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CHARACTERIZATION OF USERS OF REMOTELY-SENSED  
DATA IN THE ALABAMA COASTAL ZONE

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OF REMOTELY-SENSED DATA IN THE ALABAMA  
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Edited By:

Barry A. Vittor

With Research Contributions By:

George F. Crozier, Dan C. Holliman, J. Selwyn  
Hollingsworth, Neal G. Lineback, Carl C. Moore,  
C. Daniel Sapp, William W. Schroeder, Noel R.  
Stowe and Sidney D. Upham

Prepared By:

The Marine Environmental Sciences Consortium

For:

National Aeronautics and Space Administration  
George C. Marshall Space Flight Center

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## INTRODUCTION

### THE ALABAMA COASTAL ZONE

Legislative formation of the Alabama Coastal Area Board (C.A.B.) in 1973 was the first step in developing a centralized management program for the State's coastal environment. A major task which still confronts the C.A.B. is a legal definition of the geographical limits of the coastal zone. From an environmental standpoint, the coastal zone can include swamps, aquatic marshes and wet woodlands above the mean high water mark, which are adjacent to and impinge upon coastal habitats such as salt marshes, deltaic marshes, beaches, mudflats, bayous, oyster reefs, grass beds, etc. This qualitative description will be adopted in this paper.

The Alabama coastal zone has been studied, in varying degrees of depth, for several years. A series of ecological inventories was conducted by the Alabama Department of Conservation, Marine Resources Division during the period 1970-72. These reports reviewed existing knowledge of the hydrology, biology, geography, fisheries, and pollution problems of Alabama's estuarine areas. Dredging-related coastal environmental problems in the Mobile Bay area have also been described.

The inland boundary of the Alabama estuarine area in the Mobile River delta was identified as north latitude  $30^{\circ} 52.5'$  (mile 17.5) by the Department of Conservation (Crance, 1971). Their study area included 34,614 acres of tidal marshes (including the delta and coastline of Perdido Bay), 433 miles of open

coastline, and 620 square miles of open water. Mobile Bay has a drainage basin of approximately 44,000 square miles (Crance). This basin directs industrial/domestic effluents at the Mobile Bay estuary.

Alabama's tidal marshes were briefly described by Crance (1971). Major emergent and submersed plant species in the lower, more marine portion of the coastal zone include Juncus roemerianus, Spartina alterniflora, S. cynosuroides, S. patens, Distichlis spicata, and Diplanthera wrightii. Upper Mobile Bay is characterized by Alternanthera philoxeroides, Phragmites communis, and several species of submersed plants. The Mobile Delta is similar to upper Mobile Bay with respect to dominant flora.

Two new investigations of major coastal plant communities were initiated in January, 1975. The first will be conducted by Ms. Judy Stout of the Marine Environmental Sciences Consortium (M.E.S.C.) under the Mississippi-Alabama Sea Grant Program, and will identify and detail vascular plant assemblages at several locations in the coastal marshes. The second study, coordinated by Dr. Barry A. Vittor for M.E.S.C., will map major ecological areas in the Alabama coastal zone. Both studies are short-term, and thus will focus on selected locations for ground-truth detail, and will use aerial imagery for broad coverage of Mobile and Baldwin Counties.



Approximately 4.7 million tons of suspended sediment enter Mobile Bay (Ryan, 1969); of this amount, approximately 1.4 million tons pass through the estuary and are deposited in the Gulf of Mexico (Anon., 1973). High altitude (Skylab) photographs of the Alabama coastal zone clearly show the patterns of turbid water flow through the Bay, and into the near continental shelf. The effects of silt-laden waters on Mobile Bay are poorly understood, although siltation reportedly have been responsible for damage to oyster reefs in the upper and middle portions of the Bay (May, 1971). Ryan described the distributions of surface sediments in Mobile Bay, but neither these nor more recent data have been related to the benthic environment.

Sediment quality has been described by the Technical Committee for Analysis of Mobile Bay Dredging (Anon., 1973). However, little data has been obtained to determine patterns of sediment-transported chemical pollutants through Mobile Bay. Studies by Dr. George Crozier of the University of Alabama Marine Science Programs (NASA Contract NAS 8-30810), and Dr. Wesley Nelson of Tuskegee Institute (Sea Grant) will provide data on heavy metal and sediment transport through the mouth of the Bay. Windom (1973) studied the effects of sediment resuspension during channel maintenance dredging on heavy metal concentrations adjacent to the Mobile Ship Channel.

Pollution of coastal waters by coliform bacteria is well-documented (Anon., 1970b). Bacterial contamination of these waters has resulted in frequent closure of the State's oyster reefs to harvesting. Sources of industrial pollutants are also

known, but data are inadequate to describe patterns of dispersal of polluted waters through the coastal zone. Major and frequent fish kills have been attributed to polluted water masses (Grance, 1971), but only infrequently have the origins of these waters been identified. A large reservoir of oxygen-depleted and pulp waste-contaminated water occurs in Chickasaw Creek (Vittor, 1973). During periods of low stream discharge from the Mobile River, these waters flow into the River, where they may cause large fish kills (B.A.Vittor, undocumented).

Human influences on and uses of the Alabama coastal zone have been examined in descriptions of pollution and development (Grance, 1971; Anon., 1973). Fishery resources have been studied extensively by the Department of Conservation, Marine Resources Division (May, 1971; Swingle, 1971). Although the South Alabama Regional Planning Commission has conducted studies of economic and municipal development in the two coastal counties (Anon., 1968a; Anon., 1968b; Anon., 1970a). Information regarding the socio-economic impacts of recent and proposed coastal industrial development is sketchy. One such study dealt with the impact of the proposed superport on the Alabama coastal zone. Major industrial development north of Mobile and in the Theodore Industrial Park will have far-reaching effects on population movements and increases in the area. Such stresses will be related to the relative ecological tolerances of coastal habitats, by the M.E.S.C. study described earlier.

Historic and archaeological values are also under study. Many early European settlements and American Indian archaeological sites exist in the coastal zone. However, examination of these sites is laborious, and identification of all areas of concern has been impossible because of the large land and water area involved. Many archaeological sites have been identified via vegetation analysis. Ironically, however, few studies of Alabama coastal upland plant communities have been conducted since a study by Harper (1943) on the forests of Alabama.

Geological characteristics of the Alabama coastal zone were described by Carlston (1950). The land mass of Mobile and Baldwin counties consists largely of quartz and quartzite pebbles deposited by the Alabama River; the entire area is underlain by Pleistocene to Recent stream and estuarine deposits. Studies of these deposits revealed petroleum resources associated with the Smackover formation in south Alabama and the Florida panhandle. Considerable oil reserves have been discovered, the exploitation of which will have a significant impact on the coastal environment.

Ground-water resources also face exploitation, especially by industries which require large volumes of fresh water. A study of ground-water resources in Baldwin County has recently been completed by the Geological Survey of Alabama. According to this study, aquifers in south Baldwin County (Gulf Shores area) have become contaminated by salt water intrusion, as a

result of heavy residential demand for fresh water. Mobile County, however, appears to contain substantial fresh water reserves. A study of these reserves and possible salt water intrusion has been proposed by the Geological Survey.

## HISTORIC USES OF REMOTE SENSING IN THE COASTAL ZONE

The literature contains many examples of remotely sensed data uses in the coastal environment. Most studies have focused on mapping, hydrology and productivity measurements of coastal marshlands. Numerous similar investigations have dealt with forest and agricultural activities. Some demographic studies have been conducted.

Aerial photographic applications in coastal marsh ecology were suggested by Leuder (1959). He recommended use of color and color-infrared film to describe marsh-estuary bioenergetics.

One of the earliest photographic interpretation studies of tidal marshes was conducted by Olson (1964), who evaluated suitability of aerial photography for plant identification. He concluded that general patterns in species distributions in the coastal zone could be identified using either panchromatic or color film.

A broader study was performed by Anson (1966). Anson compared several types of aerial photographic film in his mapping of drainage, vegetation, soils and demography in a portion of the South Carolina coastal zone. A similar study, of water quality, was conducted by Strandberg (1964).

Remote sensing has been used successfully in studying marshes and estuaries. Color-infrared imagery has aided rapid description of water quality characteristics of the Maryland coastal zone (Anderson, 1968).

Other applications of various kinds of photography have included marsh productivity studies in North Carolina (Stroud, et.al., 1968) and Georgia (Gallagher and Reimold, 1972). Coastal zone mapping (generally of vegetation types) has been accomplished with remote sensing data, by Guss (1972), Reimold, et.al. (1972), and Klemas, et.al. (1973).

A more basic use of remote sensing in coastal zone studies was demonstrated by Fornes and Reimold (1973) in their examination of the "mean high water" demarcation. This line is essential to successful management of coastal resources, and has been the center of recent controversies of legal jurisdictions in man's uses of the coastal zone (e.g. via dredging, construction, etc.).

A summary of aerial remote sensing applications in coastal zone studies was prepared by Stafford (1972). He described many types of imagery, and how each might be used in coastal resource investigations.

Few remotely-sensed data studies have been conducted in the Alabama coastal zone. Notable exceptions include the use of aerial and space imagery by Lineback (1974) in a geographical atlas of Alabama. Vegetation analysis of the Tennessee-Tombigbee waterway project area was performed for the Corps of Engineers using aerial photography. Similar studies could be extended into the coastal zone to the south.

An inter-agency remote sensing study of the Mississippi Sound from Louisiana to Florida was conducted in 1971-72 under

the leadership of the Mississippi Test Facility near Bay St. Louis, Mississippi. Coastal and estuarine hydrographic parameters measured in ground-truth and aerial synoptic sampling programs included current direction and velocity, temperature, salinity, and chlorophyll.

Three archaeological studies in South Alabama have involved use of aerial imagery. Color infrared photography has been used to locate general features of Fort Toulouse (Heldman, 1973) and Fort Mims (Stowe and Hoyt, 1973). Aerial imagery was also used in an attempt by Walls (1974) to survey the Tombigbee Valley for archaeological features. Additional programs are being developed by the University of South Alabama.

## STUDY OBJECTIVES

The principal objective of this program was to identify and characterize existing or potential users of remotely-sensed data. A similar study, directed toward use of ERTS-1 data, was conducted by the Geological Survey of Alabama (Joiner, et. al.; 1974). This investigation centered on data needs and uses of local, State and Federal agencies and some private companies operating in the Alabama coastal zone.

The second objective of our project was to develop a comprehensive research program which would satisfy those user needs related to remote sensing. Research tasks were to be arranged in order of priority.

The third facet of this study involved initial investigation of the silt plume discharged from the mouth of the Mobile Bay. The ground-truth data obtained will serve as the basis for developing techniques for utilization of aerial and space imagery.

## STUDY APPROACH

The following data application categories were designated for this study (project experts are indicated for each category):

Archaeology - Mr. N. R. Stowe, University of South  
Alabama

Coastal Zone Management - Dr. Sidney D. Upham,  
Marine Environmental Sciences Consortium

Conservation - Dr. Dan C. Holliman, Birmingham-  
Southern College



Ecology - Dr. Barry A. Vittor, University of  
Alabama

Economics - Dr. Carl Moore, University of South  
Alabama

Geography - Dr. Neal Lineback, University of  
Alabama

Geology - Mr. Dan Sapp, Geological Survey of  
Alabama

Natural Resources - Dr. George F. Crozier, University  
of Alabama

Oceanography - Dr. William W. Schroeder, University  
of Alabama

In all, 62 possible users of remotely-sensed data were  
successfully interviewed, generally by personal contact. The  
following standard user poll form was used:

NASA REMOTE-SENSING DATA UTILIZATION:  
USER NEED PROFILE

1. User: Federal\_\_\_\_\_ State\_\_\_\_\_ Local\_\_\_\_\_ Citizen\_\_\_\_\_  
Industrial\_\_\_\_\_
2. User Name/Department\_\_\_\_\_
3. Contact (Individual)\_\_\_\_\_
4. Title\_\_\_\_\_
5. Date(s) Contacted\_\_\_\_\_
6. Means of Contact (Telephone, Personal, etc.)\_\_\_\_\_
7. Data Needs (attach additional sheets):
  - a. Current data usage (types, description, etc.);
  - b. Current sources of information;
  - c. Current budgeting for/collection of information;
  - d. Current interchange with other agencies/groups;
  - e. Data needs;
  - f. Format of data which is required;
  - g. Frequency of data input;
  - h. Amount and resolution of data;
  - i. Desired storage/retrieval characteristics;
  - j. Use of data which is needed.
8. Comments:

In addition, project experts met with personnel of the EROS center at the Mississippi Test Facility near Bay St. Louis, and with NASA personnel at the Marshall Space Flight Center near Huntsville.

The silt plume study, which is appended to the main body of this report, was conducted in a series of four 2-day anchor stations at the mouth of Mobile Bay. Water samples were collected at hourly intervals for 28-hour periods, at the surface, at mid-depth and above the bay bottom. Samples were analyzed for turbidity (Jackson Turbidity Units) using a Hach model turbidimeter, total suspended particulates, and organic particulates. A towed transmissiometer was purchased for the study, but was obtained in time for only the last two anchor stations.

Two additional cruises were conducted to follow the silt plume out of Mobile Bay into the Gulf of Mexico. The above parameters were measured. During both the anchor stations and the plume cruises, hydrological characteristics of the water column were measured, including temperature, conductivity/salinity, and dissolved oxygen. Current direction and velocity were measured at the anchor stations.

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## SUMMARY

The 62 current or potential users polled in this study represent the majority of agencies and groups operating in the Alabama coastal zone. The interests and applications of those contacted are understandably varied, as are their backgrounds and exposures to NASA remote sensing data.

Poll data are summarized in Table 1. These data have been condensed from interview information obtained by project consultants. A complete list of groups is given in Appendix A.

Of those agencies now using remotely-sensed data, 68% reported that they have in-house funds for either primary data acquisition (eg. ground truth surveys or fly-over requests), or for purchase of existing imagery from the EROS center in Mississippi. Most (95%) exchange data with other agencies on an informal basis. (Note, however, that this includes intra-agency exchange and interpretation, as within the Mobile District Corps of Engineers.).

Few of those users interviewed feel that they have adequate remote sensing information. In fact, many indicated that they now budget for increased data acquisition. At the same time however, most group polled would like to be provided with additional information on interpretation and application of the data purchased. This function is served to some extent by the workshop program conducted by the EROS Applications and Assistance Office in Mississippi.

Table 1. Remotely-sensed user poll summary. Numbers of respondents are given for each criterion. A total of 62 current or potential users were interviewed.

	<u>Number</u>	<u>Percent of Total**</u>
A. Type of Organization		
Federal	17	27
State	12	19
Local	3	5
Academic	16	26
Other*	14	23
B. Remotely-sensed data now used	41	66
Paid for via in-house funding	28	68
Data cost shared with other agencies	39	95
More data needed	37	90
High-resolution data	40	98
Low-resolution data	6	15
Real-time data	9	22
Weekly or monthly data	12	29
Seasonal data	15	37
Annual or less frequent data	32	78
Data interpretation performed in-house	37	90
C. Remotely-sensed data has potential use	13	21
In-house funding available	8	62
High-resolution data	13	100
Low-resolution data	3	36
Real-time data	7	54
Weekly or monthly data	6	46
Seasonal data	4	31
Annual data	7	54
D. No use for remotely-sensed data	8	13

\*Includes private companies, conservation groups, utilities, etc.

\*\*Percents of totals in sections B and C are calculated from the number of respondents in each section.



Current and projected data needs are varied, especially among the academic community. Only one of the 41 current users was not interested in obtaining high-resolution data (ie. that imagery derived from high-altitude NASA flights, and other aerial data collections). Six users employ low-resolution space imagery (eg. ERTS products); most of these users have geological or geographical applications for their data.

Several users (22%) require real-time remotely-sensed data. The U.S. Coast Guard, for example, must be able to monitor oil spills as they develop, not in retrospect. Similarly, some academic users require immediate data input for environmental monitoring and analysis. The Alabama Water Improvement Commission uses telemetry to monitor organic pollution loads in coastal streams. Less frequent data collection is used by most agencies: annual or less frequent data are used by 78% of those polled.

Potential users often lack the experience to identify probable data needs. Nonetheless, eight of 13 (62%) have in-house funding for data acquisition. All indicated that high-resolution data will be useful. Only 36% anticipate a use for ERTS-type data. Low-resolution data are considered useful in mapping and large-scale surveys of the coastal zone. Telemetric applications of space vehicles may be requested for real-time monitoring of wildlife populations. Half of those potential users interviewed have expressed a desire for real-time data, while nearly half felt that other data frequencies are also of use.

Eight of the groups polled have no need for remotely-sensed information. Most are involved in regulatory functions such as oil rig equipment monitoring, or seafood quality control. Others, such as fishery groups, do not foresee potential data applications, even though such applications may be developed. Fishery resources, for example, may eventually be monitored by remote sensing. Shrimp resources occur on the sea bottom, however, so are less easily detected by existing remote sensing technology.

Table 2 describes the degree of involvement of interviewed groups in remote sensing programs, particularly with respect to potential users or non-users. There appears to be no correlation between prior exposure to NASA-acquired data and prospective application of that data. Academic groups which are potential users include nearly equal numbers with prior exposure or no prior exposure to remotely-sensed data. Federal non-users are also divided evenly according to those criteria. It is clear that a need does exist for further publicity and education of remote sensing data programs. Innovations in the technology and in ground truth verification of simulation models will doubtless decrease the number of organizations which foresee no need for such information.

Table 2. Degree of current or potential involvement of interviewed organizations in remote sensing programs, expressed as percent of the number of each type of group polled. The numbers of respondents are indicated in parenthesis.

Organization Type	Current User	Potential User		Non-User	
		Prior Exposure	No Prior Exposure	Prior Exposure	No Prior Exposure
Federal (17)	64 (11)	12 (2)	None	12 (2)	12 (2)
State (12)	58 (7)	25 (3)	8 (1)	8 (1)	None
Local (3)	100 (3)	None	None	None	None
Academic (16)	69 (11)	12 (2)	19 (3)	None	None
Other* (14)	64 (9)	7 (1)	7 (1)	7 (1)	14 (2)

\*Includes conservation groups, industries, citizen groups, etc.

## RECOMMENDATIONS

The following recommendations have been developed from interviews with prospective users of remotely-sensed data:

Recommendation 1: Most present or potential users offered the suggestion that NASA-produced data be made more readily available to local interests. The EROS Applications and Assistance Facility in Mississippi is familiar to some users, but others are either unaware of its existence, or feel that it is not conveniently located.

Local browse files have already been established in 22 cities in the United States. Such a facility is recommended for Mobile also. Space can be made available in the new Federal Building, which is occupied largely by the Mobile District Corps of Engineers. Support for the file may be obtained from the Corps, which probably would be its heaviest user, and from some other agencies.

Space and financial arrangements should be pursued by user groups in this area.

Although many potential users expressed a desire for interpretation of data by personnel associated with a possible browse file, the financial feasibility and cost-effectiveness of this suggestion is questioned.

Recommendation 2: An equally-frequent suggestion from interviewed groups was that a workshop be held to deal with applications, accessibility and interpretation of remotely-sensed data. This workshop would represent a follow-up to the

remote sensing symposium held in Mobile two years ago. At that time, few examples of data development and application were available; consequently, most potential users were not convinced of the value of this tool to their operations.

The recommended workshop would draw upon the expertise of individuals who have used remotely-sensed data in basic and/or applied studies. Each discipline included in this project would be covered in the program. Other uses, such as those related to fisheries, would also be demonstrated for the benefit of groups which did not foresee a use for remotely-sensed data.

All groups interviewed in this investigation would be invited to participate.

Recommendation 3: Many groups have data bases which could be used by other users. Included is both ground-truth and remotely-sensed information. However, there is little communication between most agencies with respect to either data sharing or data acquisition. As a result, considerable overlap occurs in coastal zone research. Most agencies polled, and particularly those with limited investigative resources, see a need for coordination and sharing of coastal zone research data. Such coordination could be achieved via an ad hoc committee which would include all groups with an active interest in the Alabama coastal environment. A similar committee was formed in 1971 to define dredging-related environmental problems in the Mobile Bay area. The Mobile Bay Technical Committee was comprised of the Environmental Protection Agency, Mobile District Corps of

Engineers, Alabama Department of Conservation and Natural Resources, and the Alabama Water Improvement Commission. Several other agencies were invited to participate in the workings of the committee.

## RESEARCH PROGRAM

The following research program has been formulated from the project tasks outlined by each participant in this study. Other program elements may be desirable, but have not been assigned priority status in meeting the needs of agencies working in the Alabama coastal zone.

### I. GEOLOGY

Element A: Depositional history of Mobile Bay to predict future effects of man-made modification.

Element B: Evaluation of linear features in the southern parts of Mobile and Baldwin Counties, Alabama.

Element C: Compilation of aerial imagery coverage maps of Alabama.

### II. HYDROGRAPHY

Element A: Role of riverine discharge in the hydrography of Mobile Bay and Mississippi Sound.

Element B: Role of the Gulf of Mexico in the hydrography of Mobile Bay and Mississippi Sound.

Element C: Characterization of circulation patterns in Mobile Bay and Mississippi Sound.

### III. ECOLOGY

Element A: Delineation and description of ecological habitats in the Alabama coastal zone.

Element B: Relationships between coastal swamps and marshlands.

Element C: Measurement of coastal habitat productivity.

Element D: Effects of visible silt plumes on benthic fauna.

Element E: Changes in biotic potential of coastal habitats due to man's activities.

Element F: Changes in the natural coastline of Alabama via erosion and human activities.

Element G: Transport of sediments through Mobile Bay, to the inner Continental Shelf.

#### IV. NATURAL RESOURCES

Element A: Relationships between remotely-sensed data parameters and living natural resources in the coastal zone.

Element B: Characterization of vessel densities in coastal waters.

Element C: Monitoring of water temperature and/or salinity as indicators of fishery potential.

#### V. CONSERVATION

Element A: Telemetric studies of colonial nesting birds by remotely-sensed data.

Element B: Avian counts by utilization of heat sensory data.

#### VI. ARCHAEOLOGY

Element A: Identification of remotely-detectable archaeological values in the Alabama coastal zone.

Element B: Characterization of selected archaeological sites via remote sensing techniques.

#### VII. GEOGRAPHY

Element A: Geographic inventory of the Alabama coastal zone.

Element B: Compilation and comparison of physical, social and economic geographic variables in the Alabama coastal zone.

#### VIII. ECONOMICS

Element A: Characterization of population growth patterns and market potential of areas in the Alabama coastal zone.



## GEOLOGY

C. Daniel Sapp  
Geological Survey of Alabama

### INTRODUCTION

The discipline of geology concerns the study of the earth and includes, broadly speaking, knowledge of the natural phenomena within the solid earth and on its surface. It involves the study of processes operating presently or long ago. As is the case with science in general, geology has become a more restricted, more specialized field since the 19th century. This science now leaves the study of the deep parts of the earth to geophysics; the study of the atmosphere to meteorology, and the study of the hydrosphere to oceanography. Even with these restrictions, geology remains a broad science encompassing physical and biological phenomena.

Many laymen and, for that matter, some geologists, are baffled by the relationship of geology to geography. Because geography is treated in another section of this report on users of remotely sensed data, a clarification is in order. The difference is a matter of emphasis. Geology emphasizes the time dimension whereas geography concentrates upon spatial characteristics. The earth's surface is the object of geographic study whereas geology uses surface characteristics to explain the subsurface. Geography also tends to focus upon man, whereas geology is overwhelmingly concerned with natural phenomena and events. This explanation may lead one to conclude that geography,

being concerned almost totally with surface phenomena, should benefit most from the use of remotely sensed data. This observation is left for others to explore.

#### AREAS OF APPLICATION OF ERTS IN GEOLOGY

Even with its low-resolution, small-scale drawbacks, ERTS imagery may be used to obtain geologic information in many ways. If we focus on the coastal zone, we may categorize the majority of these uses as follows:

- 1) Physiographic (landforms) mapping.
- 2) Wetland-upland boundary mapping.
- 3) Location of new sanitary landfill sites and assessment of existing sites.
- 4) Water-quality analysis and monitoring.
- 5) Ground-water evaluation; well siting and tracing.
- 6) Mapping geologic formations and structure in near-shore land area.
- 7) Fault, fracture, lineament pattern analysis.
- 8) Oil and gas exploration.
- 9) Detection of contamination of surface and ground water by salt brines from oil and gas drilling activities.
- 10) Flooded and flood-prone area mapping.
- 11) Mapping salt-water intrusion-salt-water/fresh-water interface.
- 12) Mapping coastline changes-siltation, erosion and deposition.
- 13) Exploration for minerals, construction materials (sand, gravel and clay deposits).
- 14) Land-use and land-cover mapping as applied to geologic problems.

- 15) Geologic hazard detection, monitoring, assessment.
- 16) Natural disaster (hurricane and flood damage) detection and assessment.
- 17) Mapping new reservoirs and their local environmental effects.

#### SUMMARY OF CURRENT REMOTELY SENSED DATA NEEDS IN GEOLOGY

A poll of selected users, both actual and potential, in Alabama was conducted. The emphasis was on geologic applications. The two tables included in this report summarize the survey results. Table 3 considers potential users. Its message is that low-altitude aerial photography has the greatest potential, and medium-altitude photography runs a close second. Satellite imagery scored significantly lower.

Table 4 provides a profile of actual users of remotely sensed data. Again, low-altitude aerial photography scores highest in utility. Medium- and high-altitude aerial photography and aerial thermal imagery also score relatively high. Satellite imagery again scores relatively low. The Skylab photography probably rated lower than otherwise because it is not yet widely disseminated to users.

The agency making most extensive use of the data for geology is the Geological Survey of Alabama. This organization does not concentrate its efforts on Mobile Bay but does work continually on projects involving the bay. This work is usually geologic investigation on the landward side of the shoreline, with emphasis on the subsurface. The Survey also studies and monitors water resources.

Table 3. Summary of potential users of remotely sensed data in Alabama.

CURRENT DATA NEEDS	POTENTIAL USERS								
	<u>Geol. Survey, Ala.</u>	<u>St. Oil &amp; Gas Bd.</u>	<u>U.S. Bur. of Mines</u>	<u>WRRI Investig.</u>	<u>Sou. Nat. Gas</u>	<u>Gulf States</u>	<u>AL Hwy. Dept.</u>	<u>U.S.D.A. Ag. Exp. Sta.</u>	<u>Auburn Univ. Agron. &amp; Soils</u>
ERTS	X	X		Diverse and research project-oriented					
Skylab	X								
High-altitude aerial photos	X	X				X	X		
Med.-altitude aerial photos	X	X	X			X	X		
Low-altitude aerial photos	X	X	X		X	X	X	X	X
Side-looking airborne radar imagery	X								
Thermal infrared imagery (aerial)	X	X	X				X		

Table 4. Summary of actual users of remotely sensed data in Alabama

CURRENT DATA NEEDS	USERS								
	Geol. Survey, Ala.	St. Oil & Gas Bd.	U.S. Bur. of Mines	WRRI Investig.	Sou. Nat. Gas	Gulf States	AL Hwy. Dept.	U.S.D.A. Ag. Exp. Sta.	Auburn Univ. Agron. & Soils
ERTS	X	X	<u>None in Alabama</u>			*	*		*
Skylab	X								
High-altitude aerial photos	X					X	X		
Med.-altitude aerial photos	X					X	X		
Low-altitude aerial photos	X	X		X	X	X	X	X	X
Side-looking airborne radar	X						X		
Thermal infrared imagery (aerial)	X	X					X		

\*ERTS imagery consulted but judged insufficient in resolution for the task intended.

Within the Geological Survey, a division has been formed specifically to conduct research and operations in remote sensing. This is the only unit of its kind in the State government and has the largest data bank of remote-sensor imagery in the State, exclusive of NASA/Marshall Space Flight Center. The State Oil and Gas Board and the Alabama Highway Department also make considerable use of remotely sensed data, as the tables indicate.

The details of use by each agency are given in Appendix B-1.

#### NON-AVAILABILITY OF REMOTELY SENSED DATA

I feel that non-availability of data is not a serious problem. The real problem is a lack of commitment by the agencies interviewed to acquisition and use of remotely sensed data. Agencies need to assign specific individuals or groups of individuals the tasks of acquiring imagery and associated data, as well as providing assistance on call to other professionals in the agency. The situation is analogous to employment of computer programmers. No agency can seriously expect to solve problems routinely by computer without having a programmer employed there or at least on call as a consultant. A measure of commitment is needed, as well, in remote sensing.

The EROS Applications Assistance Facility, National Space Technology Laboratories, Mississippi Test Facility, is a convenient channel for ordering high-altitude aerial photography and space imagery. The data are in the public domain and are inexpensive, so neither cost of data acquisition nor non-availability of data

is a real problem. Commitment and education (training) in remote sensing are the problems to be overcome.

#### DEVELOPMENT OF A DATA BASE

Regional centers within Alabama should be established for the convenience of remotely sensed data users, with equipment and skilled personnel available to assist the local users. Two regional centers are proposed; one in south Alabama and one at the Alabama Geological Survey in Tuscaloosa. Accessibility and convenience to the user dictate that a center somewhere in central Alabama be established to complement one in south Alabama. Since the Survey has a viable, existing unit for remote sensing, this seems to be a good choice. Both of these centers should have one or two professionals available to assist visitors, and the following equipment:

- 1) A "browse" file system consisting of a microfilm reader and regularly updated microfilm cassette catalog of imagery.
- 2) Optical instruments for detailed viewing of film.
- 3) Map library and standard reference library.

The funding for these centers should be done through a cooperative agreement among the University system and State agencies being served. Considerable "housekeeping" is involved in maintaining a data bank. Imagery coverage plotting, briefing users, and ordering new imagery are time-consuming tasks. A rough estimate of the time and money spent on these tasks at the Alabama Geological Survey is approximately twenty (20) man-hours per month.

## PROPOSED DATA COLLECTION TECHNIQUES AND DESIRED CHARACTERISTICS OF DATA

Consolidation of these efforts seems to be the key to success. Aerial photography is being flown by several agencies, both public, governmental, and private. In general, there is little communication among the agencies except by "grapevine". For example, I have heard that the Alabama Department of Revenue has contracted and obtained aerial photography over the state, but have never seen documentation on it. Obtaining information on these flights is not so easy as a phone call. In fact, some agencies jealously guard their data. Somehow, consolidation of these acquisition efforts must be done. It is not uncommon for one agency to contract aerial photography of an area when it has been flown recently by another agency. Thousands of dollars of taxpayers' money have been wasted in this way.

Of course, repetitive remote-sensing coverage of selected areas is not always a waste. It is often necessary. This procedure merits further discussion.

### REPETITIVE COVERAGE REQUIREMENTS

Frank G. Zarb, Office of Management and Budget associate director for natural resources, energy, and science, told the Senate Aeronautical and Space Sciences Committee in September 1974, that insofar as geology is concerned, "...additional coverage with the same technology [ERTS] has relatively low value once complete cloud-free coverage is obtained" (Aviation Week and Space Technology, September 23, 1974, p. 24). This



possibility is certainly worth considering but overlooks the importance of ERTS for detecting natural calamities and geologic hazards. The greater the image resolution, the more value repetitive coverage will have, because as more detail is seen, more minor geologic hazards may be studied. So once-over coverage is not sufficient in geology. Dynamic features are studied in hydrology -- for example, new sinkholes in carbonate terrane, or fluctuations in the near-surface water table -- and repetitive coverage is a must.

If we accept the fact that repetitive coverage is desirable, then at what frequency? The 18-day cycle of ERTS-1 appears adequate, according to statements of the majority of users. Since the earth is more than 50 percent cloud-covered, on the global average, this means most areas should be imaged cloud-free once about every one to two months. "Usable" imagery could be defined as being of good quality with 10 percent or less cloud cover, but this is a generalization.

The dynamics of near-shore areas certainly merit frequent repetitive coverage. The problem here is not the frequency but the timing of the overflights.

Some investigators would like to have imagery during a certain tidal stage in a particular area, or during specific current conditions. Coverage immediately after hurricanes would be desirable. Here we are talking about a flexible schedule, or variable frequency of coverage. This could be accomplished with several orbiting satellites with sensors that

could be energized only when needed. A real-time system where local centers could relay requests for coverage of their area at a specific time to NASA/Goddard could be initiated.

ERTS-1 always passes over Mobile Bay southbound at approximately 10:00 a.m., CST every 18 days and this presents a problem for these investigators concerned with tidal cycles. In geology, however, this consistency is an asset. The low sun angle accentuates land relief features (topography) and images obtained at different dates the same season may be compared conveniently. Aerial photography, on the other hand, is not usually available over large areas with the same sun angle, and illumination is noticeably variable.

#### RESOLUTION REQUIREMENTS IN GEOLOGY

Geology is an intensely practical science and remotely sensed data have found considerable utility; this use is increasing. This trend toward greater use is apparent despite widespread disenchantment with ERTS image resolution and small scale. (ERTS imagery cannot be enlarged beyond the scale of 1:250,000 without excessive degradation.) Many geologists feel that ERTS image resolution is being restricted below that which could be achieved with line-scan systems, and that the system should be improved to conform to the actual state-of-the-art in remote-sensor technology. The reasons for this restriction are not clear but must be a result of National or International agreements. The orbiting of a satellite with high-resolution

cameras could anger foreign governments. What is clear is that ERTS image resolution is insufficient for most geological studies. This conclusion is documented in the user interviews in this report. So many geologic tasks require imagery of high resolution; for example, detection of new collapses (sinkholes) in carbonate terrane is impossible using ERTS imagery.

Even with these shortcomings, the apparent consensus among geologists is that ERTS-1 is the most geologically significant new source of remote-sensor imagery. The repetitive coverage and large-area, synoptic view are its strong points for geology. Comparative interpretation of images from different seasons of the year does permit identification of certain phenomena that would otherwise be unknown. Comparisons of images obtained more frequently have proved their value for hydrogeologic studies in coastal areas such as Mobile Bay.

Many geology investigators have described successful applications with ERTS. Some of these conclusions were based on insufficient evidence and the information obtained ostensibly from the imagery was instead drawn almost completely from ground-based sources (field observations). It is not the use of ground-based data that is objectionable (quite the opposite), but, instead, the inference or statement that ERTS data were the source when this is untrue.

Geologists in general are optimistic, even enthusiastic, about the currently available high-altitude aerial imagery. This is the photography -- color or black-and-white infrared -- from

the RC-8 and RC-10 cameras on NASA's U-2 and B-57 aircraft. This photography is for the most part obtained from altitudes of 55,000-65,000 feet. The image scales are small but ground resolutions are very good (resolutions on the order of 10-15 feet on the ground are possible\*). This acclaim is well deserved and should trigger the demand for more frequent overflights.

The trend towards more frequent use of high-altitude aircraft for remote sensing is supported by Zarb, who recommends this technique and is generally negative about the value of ERTS data (Science, V. 186, November 29, 1974).

#### RESEARCH PROGRAM

It is suggested that the regional user centers be established in Alabama through a cooperative NASA-Alabama user program. Funding should be allocated to set up these centers, furnish the equipment, and provide incidental aid. Then the users could pick up the responsibility and continue the program under a well-defined cooperative agreement with NASA.

It is impossible to provide a comprehensive description of all possible geological research desired in the Mobile Bay area,

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$$\text{*Ground resolution in feet} = \frac{\text{Scale reciprocal}}{304.8 \times \text{mm resolving power}} = \frac{130,000}{304.8 \times 32^{**}} = 13.3 \text{ ft.}$$

\*\*Resolving power of Kodak Aerochrome IR 2443 film at T.O.C. of 1.6:1 is 32 lines/mm

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but a few recommended proposals are presented. These ideas are judged appropriate at this time and they merit funding. They are not assigned any priority but are arranged in sequence alphabetically by investigator.

A detailed budget estimate for any or all of these recommended projects will be furnished upon request.

<u>Proposed Project</u>	<u>Investigator and Agency</u>
1) Depositional history of Mobile Bay to predict future effects of man-made modification	P. A. Boone Chief, Energy Resources Division Geological Survey of Alabama
2) Evaluation of linear features in the southern parts of Mobile and Baldwin Counties, Alabama	C. W. Copeland Chief, Geologic Division Geological Survey of Alabama
3) Compilation of aerial imagery coverage maps of Alabama	C. D. Sapp Chief, Remote Sensing Division Geological Survey of Alabama

Task 1: Depositional history of Mobile Bay to predict future effects of man-made modification. The Mobile Bay estuarine system is located in a rapidly growing major population center. Man-made modifications are beginning to change many of the natural erosional and depositional features of the shoreline of the bay. These features record the effects of processes that have shaped the bay and as such afford an unparalleled opportunity to develop a history of these events. With this type of background data it will be possible to plan for the more judicious land-use management of this irreplaceable natural resource of both Alabama and the Nation.

Major depositional features that may tell much about the history of Mobile Bay since sea level rose to its present level occur in three areas: 1) along the east side of the bay, 2) along the west side of the bay, and 3) along Point Morgan peninsula.

The eastern shore of Mobile Bay, south of Point Clear, consists of beaches backed by low marshy ground alternating with marsh. This is a large depositional feature formed since sea level reached its present level. An understanding of the development of this shore should shed considerable light on the history and circulation of Mobile Bay.

The western shore of Mobile Bay consists of alternating beaches and marsh fronting a broad low plain termed Coastal Lowlands. Several prominent geomorphic features on the plain are interpreted as depositional in nature. The formation of these features and the development of the broad Coastal Lowlands have undoubtedly played an important part in developing the Bay in its present form.

A series of at least three sets of intersecting beach ridges occurs on Point Morgan peninsula. These ridges reflect a rather complex history and development of this peninsula which undoubtedly have had great influence on the history and circulation of Mobile Bay.

Each of these three areas will add important data to our understanding of Mobile Bay; data that will aid in developing the capability of predicting the effects on man-made modifications to the bay. As such, each is important. However,

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priorities can be assigned. Without doubt Point Morgan peninsula is the most important of these areas, followed by the western shore of the bay. The eastern shore should probably have the lowest priority although it may shed considerable light on the effects of the tidal prism in Mobile Bay.

The study of these features will combine field and laboratory investigations. Field studies will entail collecting undisturbed cores of the total Holocene sediment section in selected locations. The cores will be used to develop the stratigraphy and depositional history of these deposits, characterization of sediment types and to collect fossil materials for paleontologic studies. The cores will be supplemented by the study of trenches in selected localities that will afford a larger area for study in three dimensions. Lab work will include testural and paleontologic studies of the materials collected. Selected carbonaceous materials, if encountered, will be C-14 dated to allow the deposits to be dated.

It is estimated that two years will be required to complete the study. The study will require two professionals for a total of two man-years and two sub-professionals for a total of 36 man-months. The cores will be an additional expense which will be determined by the number of cores selected. A total of 20 or 30 cores should suffice.

Task 2: Evaluation of linear features in the southern parts of Mobile and Baldwin Counties, Alabama. Prominent lineaments visible on Apollo 7 photography and ERTS-1 imagery of Mobile and Baldwin Counties have been interpreted as fault traces by W. C. Isphording and J. F. Riccio (1974).

Sediments in the area are of mixed fluvial, deltaic and marine origin and are composed mainly of essentially flat-lying deposits of sand, gravel and clay. The sediments range in age from Miocene to Pleistocene.

The mapping of faults in sediments of this type (with limited traceable marker beds) is difficult, but field studies should be made to evaluate the features that have been reported. The faults, if present, may be an indication of very recent tectonic activity in southwestern Alabama.

The results of the proposed study will be of principal concern in the location of oil and gas transport and refining facilities being considered in the coastal area.

Work Plan: A study to evaluate the linear features can be accomplished in three phases as follows:

Phase I, Photo and Imagery Interpretation

Studies of the linear features will be made from satellite imagery, high-altitude aerial photographs and conventional aerial photography to accurately transfer the lineaments from photographs to the available 7.5- and 15-minute topographic quadrangle sheets. The photographs will be checked carefully for the occurrence of sag ponds along the traces of lineaments, for disruption in



drainage patterns, and for any obvious contrasts in sediment character and patterns of distribution. Approximately 10 days will be required to complete Phase I.

#### Phase II, Field Investigation and Evaluation of Linear Features

Field investigations of the traces of the lineaments will be made to determine relationships to possible faulting. The vertical control for formation contacts mapped in Mobile and Baldwin Counties is available to the project. Time and mileage estimates for Phase II are 30 days per diem expense and 2,500 vehicle miles.

#### Phase III, Report Preparation

A report summarizing the results of the photo interpretation and field investigations will be prepared upon completion of Phase II and will require 10 days.

Schedule: Time for completion is estimated to be two calendar months and the work should be done during the winter months when at least a part of the vegetation in the region is dormant.

Reference: Isphording, W. C., and Riccio, J. F., 1974.  
Use of satellite imagery in interpretation  
of physiographic and structural features in  
south Alabama: Bull. Am. Assoc. Petroleum  
Geologists, V. 58, No. 3, P. 528-532.

Task 3: Compilation of aerial imagery coverage maps of Alabama. Indexes showing plots of all available aerial photo coverage of Alabama and listing the data characteristics and sources would be compiled and disseminated widely to the users and potential users of remotely sensed data in Alabama. Examples

of each type of imagery would be included in the publication. Moreover, as new imagery is flown, the maps would be updated and disseminated on a quarterly basis, as supplements.

Work Plan: An initial publication would be prepared to depict all aerial imagery coverage of Alabama for the past ten years (that is, since January 1, 1965). Reduced base maps would be annotated with the flight lines and mission/frame numbers. Sources of the data would be indicated, as well as image quality and other characteristics.

Schedule: Six months would be required to compile the original publication. Supplemental issues (updates) would be issued quarterly. The formats would be compatible with the original publication.

Scope: Since satellite coverage maps are widely available through NASA and USDI EROS program sources, inclusion of these data is not considered necessary. The indexes being discussed would include all forms of aerial imagery but not orbital imagery.

Costs: Six man-months will be required to compile the initial publication. Reproduction and printing costs will be extra. The quarterly supplements (updates) could be produced for a few man-days each. Several hundred copies of each publication will be needed to cover the user community in Alabama. Exact figures will be provided upon request.

## HYDROGRAPHY

William W. Schroeder  
University of Alabama Marine Science Programs

### INTRODUCTION

During this study and for the purpose of this report the term "hydrography" has been defined as the physical behavior of the brackish and saline waters that are geographical associated with the study area. Because of the emphasis placed upon the utilization of NASA remote-sensed data (imagery and photography) and the limited ability of extracting from these data information from beneath the "surface features" particular attention has been placed on "surface" waters.

The dynamic character of the waters associated with the coastal zone, due to astronomical and meteorological conditions as well as terrestrial water run off, create extremely complex and highly variable circulation patterns. This in turn produces complicated and rapidly changing horizontal and vertical patterns of all the environmental parameters.

Because of this situation the large scale geographic coverage that the various forms of imagery afford become a useful tool to those agencies and investigators that are either directly or indirectly concerned with the circulation within the study area.

Areas of Application of NASA Remoted-Sensed imagery and photography in the "Hydrography" of Alabama's Bay/Estuary system.

- 1) Characterization of surface circulation patterns
- 2) The role of Terrestrial water run-off in the surface circulation patterns

- 3) The role of Gulf of Mexico waters in the surface circulation patterns
- 4) Any study requiring knowledge of the possible origins and/or the fate of any material transported by surface waters

#### NON-AVAILABILITY OF DATA

The problem of non-availability of data is essentially one of the potential users not being aware of how to obtain existing data rather than the acquisition of new data. Once a "potential user" (see Tables 5 and 6) has received existing data and has developed into a "user" it is highly likely that they will identify new data requirements and request additional coverage (i.e. geographical, specific time or sequential sets). With the exception of the Marine Science Programs of the University of Alabama, all other organizations interviewed were potential users.

#### DATA BASE DEVELOPMENT, DATA PUBLICITY AND DATA DISSEMINATION

In order to properly and adequately introduce all potential users to the above mentioned phases, encouragement should be given to utilize the EROS Applications Assistance Facility at the National Space Technology Laboratories at Bay St. Louis, Mississippi. Further specific aid to the user will only come about when "specialty centers" are created where resident staff members, who are personally involved in research, can amass the needed data for a data base and also advise and participate in aiding potential users and users. The ideal location for a "Hydrography Specialty Center" is the Dauphin Island Sea Lab.

Table 5. Summary of Data Needs

ITEM: 1		2	3					
<u>Organization</u>	<u>User</u>	<u>Potential User</u>	<u>No Application</u>	<u>ERTS</u>	<u>NASA-AIRCRAFT</u>	<u>Skylab</u>	<u>Thermal Infrared</u>	<u>COMMENTS</u>
1		x		x	x	x	x	
2a		x		x	x	x	x	- ERTS for patterns - Multi-coverage for monitoring
2b		x		x	x	x	x	- ERTS for patterns - Multi-coverage for monitoring
2c			x					- needs are real time
2d	x			x	x	x	x	
3a	Interview not completed							
3b			x					- needs are real time
4a			x					- Regulatory office only
4b		x			x	x	x	- Multi-coverage over tidal cycles
5		x			x			- requires detailed resolution - Multi-coverage for environmental monitoring

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Table 6. List of Organizations Contacted  
During This Study

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1. Mobile Oil Corporation (New Orleans)
  2. State of Alabama
    - a) Bureau of Inspection
    - b) Bureau of Laboratories
    - c) State Docks
    - d) University of Alabama - Marine Science Programs
  3. U. S. Department of Commerce
    - a) National Marine Fisheries Service (Pascagoula)
    - b) National Weather Service (Bates Field)
  4. U. S. Department of Health, Education and Welfare
    - a) Food and Drug Administration (Mobile Office)
    - b) Gulf Coast Technical Services Lab (F.D.A.)
  5. U. S. Department of Transportation  
U. S. Coast Guard
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## FUTURE DATA REQUIREMENTS

The only "users" identified in this report are the resident Marine Science Programs staff members at the Dauphin Island Sea Lab. Refer to Appendix B-2 for comments.

## RESEARCH PROGRAMS

Because of the dynamic and variable nature of the coastal and estuarine "surface waters" the paramount problem facing the scientist today is understanding the basic behavior of these "surface waters". Before productive practical end results can be expected through utilization of remote sensed imagery, two objectives must be reached: (1) the basic descriptive nature of these surface waters must be documented; and (2) an overall understanding of the hydrography of these surface waters which approaches "positive feature identification"\* capabilities must be attained.

To meet these two objectives a board sampling program consisting of: (1) a minimum of four evenly spaced full tidal cycle study periods per calender year (in order to observe seasonal trends); (2) a minimum geographical coverage which

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\*Because the character of "surface waters" is constantly changing it is seldom possible to have a second chance to photograph exactly the same set of conditions (as for example, a geologist can when dealing with geological formations). Therefore the marine scientist must have sufficient knowledge and experience in order to make a one chance only "positive feature identification".

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includes the Mobile Bay main pass, the Mississippi Sound - Mobile Bay Pass, the Alabama portion of East Mississippi Sound and an upper and lower division of Mobile Bay; (3) the ability to sample on a "target of opportunity" bases (notification of less than 24 hours) either specific features or a specific geographic area or during a specific time period; and (4) continuous monitoring of "indicator spots" in order to have real time data input. The selection of parameters to be measured will be dependent in part on economical considerations, power requirements, data logging format and scaffing as well as the choice of instrumentation platform. The minimum requirements should be temperature, conductivity (salinity), current speed and direction and alpha coefficient (percent transmission of light).



## ECOLOGY

Barry A. Vittor  
University of Alabama Marine Science Programs

### INTRODUCTION

The Alabama coastal zone represents a group of complex ecological habitats, each of which must be considered in implementation of management guidelines. Although this upland and estuarine area contributes to the rich natural resources of the northeastern Gulf of Mexico (and Mobile Bay), there is little information on either the distributions of organisms present or their roles within the coastal ecosystems. Our knowledge of the impact of other areas (for example, upriver industrial regions) on the coastal zone is equally undefined.

Ironically, local, State and Federal agencies are now in the position of developing and implementing regulations concerning the environmental aspects of man's use of the coastal zone, even though adequate data seldom exist. This survey of actual and potential users of remotely-sensed ecological data is intended to describe the types and applications of data now available or needed by these agencies. In many cases, agencies lack experience in dealing with remotely-sensed data. An exception is the Army Corps of Engineers, which has published an in-house document on Corps studies which develop use this source of environmental information. Their programs have been described in detail in the General Introduction.

Several other agencies were contacted during this study in order to develop a user need profile for ecological data. The complete list of potential users interviewed follows:

1. Alabama Attorney General's Office
2. Alabama Water Improvement Commission
3. Mobile District Corps of Engineers:
  - a. Environmental Resources Branch
  - b. Harbor Development Section
  - c. Operations
  - d. Permits
4. U. S. Geological Survey, Metairie (Louisiana)
5. University of South Alabama, Biology Department

#### SUMMARY OF USERS PROFILES

Of the above agencies, the U.S.G.S., Metairie is the only one which does not foresee a need for remotely-sensed data. Their operation requires *in situ* monitoring of oil platform systems and discharges, including produced discharge water oil content, solid content, pH, conductivity and temperature. They now employ field personnel to measure these parameters and verify that control systems are operable on each platform. Although aerial photography probably will not satisfy needs of this kind, telemetric monitoring of such systems may be feasible and should be pursued.

Four of the other groups polled (see Table 7) also use ecological data for regulatory or legal purposes. Consequently,

Table 7. Profiles of actual or potential users of ecological remotely-sensed data.

	USER NUMBERS*
Current Data Usage:	
Mapping	2, 3, 4, 5, 6, 8
Vegetation Analysis	3, 5, 8
Water Quality	1, 2, 3, 5, 7, 8
Human Activities	1, 2, 3, 4, 5, 6, 7, 8
Upland Topography	3, 5, 8
Bottom Profiling	3, 4, 5
Ecological Processes	2, 3, 5, 8
Coastal Processes	4, 5
Fishery Resources	1, 3, 5, 8
Pollution Sources	1, 2, 3, 5, 7, 8
In-House Data Collection	2, 3, 4, 5, 6, 7, 8
High-Altitude Imagery	1, 3, 8
Low-Altitude Imagery	1, 3, 4, 5, 6, 7, 8
Telemetry	2, 7, 8
Input Frequency:	
Monthly	1, 2, 3, 7, 8
Seasonal	1, 3, 4, 5, 8
Annual	4, 5, 6, 8
Input Resolution:	
>60 m	1, 3, 4, 5, 6, 7, 8
<60 m	1, 3, 8

\*User numbers are given on page 52.

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the degree of data detail and resolution now used by them must conform to the specifications of State and Federal environmental laws. Each group obtains in-house (ie. direct State or Federal) funding for the collection and/or review of ecological data. The Alabama Attorney General's Office, however, relies most heavily on useable data bases from responsible sources (eg. the Water Improvement Commission, Conservation Department, University of Alabama, Geological Survey of Alabama, Corps of Engineers, and others).

The Attorney General's Office has made use of remotely-sensed data in the past, especially for initial detection of violations of State or Federal laws. High altitude (eg. Skylab) false infrared photo imagery was used to identify a major source of siltation in Mobile Bay, in 1974. However, low-altitude (2000 feet) aerial photography, plus ground-truth field reconnaissance was - and generally is now - necessary to obtain legally acceptable information.

The Permit Section of the Mobile District Corps of Engineers also has a need for low altitude imagery, because structures of activities smaller than 200 feet in size must be monitored in the coastal zone. Small dredge and fill operations, boat docks, and bulkheads may not be detectable from U-2 or RB-57 data sources, much less from ERTS or Skylab operations. However, false infrared photography has been used successfully in environmental assessments of major waterway-related activities. High altitude (RB-57 and Skylab) imagery has proved invaluable to the Environ-

mental Resources Branch of the Corps of Engineers, particularly in evaluations of the Tennessee-Tombigbee waterway project. Vegetation and specific habitat mapping has been accomplished in these studies, involving considerably more area than could be covered by conventional field methods. A basic need for ground-truth data has been cited nonetheless.

The Operations office of the Mobile District Corps of Engineers currently uses ground-level data gathering techniques for characterizing channel conditions in Alabama and other coastal waters. Bottom contours, shoaling processes and other features must be monitored constantly by these methods. Application of remote sensing imagery to this problem has not been pursued, although preliminary evaluation of density-slicing techniques suggests that remote photography may be able to characterize bottom topographies in shallow bay waters.

The Operations office also has responsibility for monitoring natural resources which may be affected by its dredging or maintenance projects. The status of oyster reefs, submersed grass beds, marshes, and other habitats is determined via field studies and aerial imagery. Most of the actual data collection and processing is performed by the Environmental Resources Branch or the Permit Section of the Corps of Engineers, as described above.

The Corps' Harbor Development Section uses both field and aerial survey data to determine erosion rates and patterns in the Mobile Bay area. High altitude (60,000 feet) imagery may be useful if changes of less than 50 feet in distance can be measured.

Many of the problems and data uses described above are also of interest to the staff of the University of South Alabama's Department of Biology. This interest is generally not defined, or limited to a specific problem-solving investigation. Rather, occasional use has been made (and is expected to be made in the future) of remotely-sensed data. In general, low altitude aerial photography is most desired, particularly for the characterization of coastal vegetation. Two studies now being conducted by one U.S.A. staff member through the Marine Environmental Sciences Consortium will require both high and low altitude imagery for this purpose. As this tool is advertised within that department, more uses will doubtless develop.

In all of the above cases, the format and frequency of data input focuses on low altitude photography, as often as economically feasible (Table 7). The specific problem under study, or the activity being monitored, has certain tolerances for both parameters, of course. For example, monitoring of coastal streams for dissolved oxygen consumption should be conducted daily, according to the Alabama Water Improvement Commission. However, monthly sampling (whether by telemetry or by manual measurement) is adequate. The Permit Section of the Corps of Engineers, on the other hand, required the least frequent data collection: complete aerial photographic coverage of the coastal zone is necessary every one or two years. Many groups feel that seasonal (or at least, biannual) data collection is adequate. Again, however, the timing of data collection must be geared to

the specific problem studied.

Appendix B-3 summarizes interviews with each of the above groups.

#### RECOMMENDATIONS

A general lack of familiarity with the types of telemetry and imagery available prevents most agencies and individuals from identifying either needs or applications of remotely-sensed data. All users polled feel that a series of workshops or seminars, or a full symposium on remote sensing technology and application would be of great value to their programs. Such a recommendation is described in detail in an earlier section of this report.

A second recommendation of most users is that local data source centers be established to coordinate collection and dissemination of remotely-sensed data, as well as other types of data. In this area, such a center has been suggested for Mobile. The information center concept varies from one agency to another, but should at least provide an outlet for NASA and other aerial photography. This would be developed as a browse file for users of EROS-handled imagery. Secondarily, the center would make available data from the various local, State and Federal agencies engaged in coastal zone studies. This recommendation is also described in detail in an earlier portion of the MESIC report.

A common concern of all users of both conventional and remotely-sensed data is that the data collection programs and/or research activities of all groups working in the coastal zone should be publicized to those public agencies requiring data for regulatory or other functions. Many agencies overlap in their field programs, or are unaware that needed data already exist. A central data storage/retrieval system similar to that subscribed to by the Alabama Water Improvement Commission - STORET - has been recommended for ecological information. Such a system has been developed in Texas by the Gulf Universities Research Consortium, and is now being used by the E.P.A. and Corps of Engineers.

#### RESEARCH PROGRAM

The following research program is designed to meet the expressed needs of remotely-sensed data users in coastal and estuarine ecology. The Ecological Inventory and Ecological Effects section of the program should be conducted simultaneously. The former will benefit from some current investigations, but will also be pursued for ground-truth data in support of Ecological Effects studies. Tasks are arranged in order of priority in each section.

#### ECOLOGICAL INVENTORY

Task 1: Delineation and description of ecological habitats in the Alabama coastal zone. This task will require ground-level and aerial examination of natural or induced boundaries between



marshes, swamps, coastal woodlands, dunes, beaches, mudflats, and open-water areas. Major plant components will be identified, with increasing reliance on high-altitude imagery.

Task 2: Relationships between coastal swamps and marshlands.

Water flow patterns linking swamps and marshes will be described at selected sites. Nutrient transport between habitats will be determined in order to characterize the trophic relationships between these areas. Suspended solids transport, and any other parameters considered significant by the investigator, will be quantified.

Task 3: Measurement of coastal habitat productivity.

Biotic production and habitat health will be assessed via ground-truth and remote techniques. Habitats which should be emphasized are marshlands (Deltaic and coastal), swamps, and woodlands. Techniques for measuring open-water productivity using remote sensing should be assessed.

#### ECOLOGICAL EFFECTS

Task 1: Effects of visible silt plumes on benthic fauna.

Sediment accumulation in areas of high turbidity will be related to temporal and/or spatial changes in benthic infauna. Study locations should be selected to compare sediment type and fauna in areas below unnatural silt plumes with areas not subjected to each human activity-related pollution.

Task 2: Changes in biotic potential of coastal habitats.

This study will focus on changes in habitat size and quality

caused by human activities (dredging, pollution, construction, etc.). Important aspects include reduction of submersed grass beds, reduction of marshlands, disruption and siltation of oyster reefs, dune and beach modification, and swampland reduction. Characterization of each of these areas with respect to ecological value will have been established prior to, or concurrently with, Task 3 in the Ecological Inventory.

Task 3: Transport of sediments through Mobile Bay, to the inner Continental Shelf. The heavy seasonal turbidity plume emanating from Mobile Bay will be measured for several water quality parameters, including sediment load, selected heavy metals, nitrates, phosphates and organic solids. Sediments in the path of the plume will be sampled for particle type and size distribution. Benthic infaunal assemblages will be described and related to sediment characteristics. The remotely visible plume will be mapped seasonally, and related to benthic studies.

Task 4: Changes in the natural coastline via erosion and human activities. Mapping and quantification of erosion processes in the coastal zone will be accomplished using aerial imagery. Sediment transport patterns (shoals, bars, etc.) will be described and related to these coastal processes. Effects of construction, channel development, etc. on the natural coastline will be described and measured over time, using historic and new aerial photography and survey data.

## NATURAL RESOURCES

George F. Crozier  
University of Alabama Marine Science Programs

### USER SUMMARY

This rather amorphous group ultimately reduces to the "professional" sports fishery, in the form of the charter boats and the commercial fishermen of either finfish or shellfish. Secondarily surveyed were the scientific units researching the "pollution" problems directly affecting the waters in which these fishing industries operate.

The immediate problem is that the majority of the "catch" includes demersal forms, and the penetration of the remote sensing vehicle becomes of paramount importance. At the moment, there seems to be little concern among these groups for information on the surface numbers or activities of the fleet, whether it be charter boats, trawlers or oyster catchers. I believe that some of the management agencies would however like to have that type of information.

The most pertinent argument that I can develop from these group interviews is a need for a pedagogical "interpreter". I don't believe that these largely non-scientific users understand what could be available to them from remote sensing. But under any circumstances there must be someone or some agency which is familiar with the various techniques of both the fisheries and remote sensing. This unit must in some manner have access to the data and have the insight to extract that which may be useful

to the fisherman. I do not believe that they will pursue it on their own.

User interview summaries are included in Appendix B-4.

## RECOMMENDATIONS

Within this context, a "browse-file" would be of little value to this group unless there were also some low-key educational and public-relations type efforts initiated. This would conceivably include expanded media exposure to remote sensing techniques and capabilities. The increasingly common problem of ultimate people-power is quite evident in this situation and their awareness must be brought to bear on the situation.

I would specifically recommend that some work along the above lines be negotiated with the Mississippi-Alabama Sea Grant Advisory Services. This agency has demonstrated a rapport with many resource users and also has the diverse capabilities to deal with such a program.

## RESEARHC PROGRAM

- 1) Relation of remotely sensed data (temperature, turbidity) to living resources.
- 2) Expand public awareness of remote-sensing potential to a greater proportion of general population.
- 3) Develop means of expedition, processing and promulgating data of potential interest:
  - a) Vessel densities
    - 1) Qualitative determination

b) Circulation as possibly determined by:

1) "turbidity"

2) temperature

3) chlorophyll

c) Temperature (as it affects sports and commercial fishers)

## CONSERVATION

Dan C. Holliman  
Birmingham-Southern College

### INTRODUCTION

Conservation is a multi-faceted discipline that is constantly evolving due to the pressure of several factors. In the early 1960's, Federal emphasis was strongly placed upon environmental stress. This has given rise to numerous new major environmental "action" groups, and has provided additional importance to those traditional organizations that have always been aware of long term changes in our environment. This movement has been felt at the grass root level and has consequently been reflected in the policies of both State and Federal agencies. Undoubtedly with the selective pressures of the various crises, such as the reality of the energy shortage, inflation, and recession, areas of importance in conservation will change almost in a predictable mode.

In the southeastern United States and specifically in Alabama the following represent, at this point, major areas of concern:

Land use: Changes in our land, and subsequent management policies, will necessarily have to be considered over the long haul. This necessitates continual monitoring. Present day remotely-sensed data nad imagery is adequate to provide the needed information. Refinement of these techniques, particularly as related to the qualitative and quantitative analysis of plant community structure, could greatly enhance this effort.

Pollution: The detection of pollution sources and the assaying of pollution levels is of utmost importance. Costs and legalistic considerations will be prime factors in making this type of data generally available to the various agencies and to the public.

Population dynamics (Wildlife): This probably represents the most exciting possibility of the utilization of our "new tool". Preliminary work with telemetry has indicated that additional refinements are necessary in order for the gathering of data on a range wide basis. This will come only with added costs either to NASA or to the users themselves if they decide to pool their resources.

Other uses: Various other uses of remotely-sensed data and imagery can be realized by dove-tailing their objectives with other on-going projects in disciplines besides that of conservation. A description of "other uses" follow in section 2.

#### USER SUMMARY

A summary of current data needs follows. Refer to Appendix B-5 for a detailed description of the uses for each agency interviewed. The following groups were contacted:

- (1) - Alabama Department of Conservation and Natural Resources
- (2) - Alabama Conservancy
- (3) - Alabama Marine and Seafood Division
- (4) - Alabama Power Company
- (5) - National Audubon Society
- (6) - U. S. Department of the Interior, Fish and Wildlife Service

<u>Data Needs</u>	<u>User</u>
A. Land use	
1. Agricultural patterns	(1, 6)
2. Vegetative patterns	
a. Continental	(5, 6)
b. Marsh lands	(3, 6)
3. Mono culture	(2, 6)
4. Strip mining	(2, 6)
5. Cartography	(4, 6)
B. Pollution	
1. Thermal	(1, 2, 4)
2. Particulate	
a. aerial	(2, 4)
b. water	(2, 1)
C. Population dynamics (wildlife)	
1. Waterfowl survey	(1)
2. Telemetry	(1, 5)
3. Identification of breeding bird colonies	(5)
D. Other	
1. Population dynamics (human)	
a. Population centers and movements	(2)
b. Boat counts	(1)
c. Traffic patterns-boat	(1)
2. Hydrography	
a. Circulation patterns	(3)
b. Detection of pot holes	(5)
3. Inventory of coal reserves	(4)

The following types of data are either not readily available, or if they are available, refinement or additional research is needed before techniques are usable.

- a. Telemetry on a range wide basis
- b. Vegetation analysis (ecotones) of communities
- c. High resolution of prints
- d. Circulation patterns of Mobile Bay



One of the main problems voiced by potential users is the absence of a centrally located source from which data could be retrieved with a minimum of time and red tape. Perhaps with the establishment of the browse file system, this problem will be mitigated. State agencies could probably use a single source (e.g., Agricultural Department) to satisfy their needs. All sensory data could be channeled into this agency for the appropriate distribution. The U. S. Department of the Interior already has established a Remote Sensing Section in Washington, D. C. Personnel staffing this office came from the Bay St. Louis, Mississippi facility. The U.S.G.S., Tuscaloosa, Alabama probably represents the most appropriate center for citizens use because of its knowledgeable staff in the Remote Sensor Technology section. At the present time there is no funding for the U.S.G.S. to handle overhead costs that would accrue if this service was to be used at its maximum capacity (duplication, distribution, staff time, etc.). Mr. Daniel Sapp, U.S.G.S., has estimated that a 10% overhead cost would be a realistic estimate for funding such an operation.

The following statements represent typical user comments regarding existing or projected data collection techniques, sensitivity, resolutions, applicability or general criticisms that might help guide future remote sensing and ground truth data collection studies. These statements are not listed in any order of priority or importance.

- a. Resolution is not adequate to detect individual organisms, such as birds or mammals.
- b. Telemetry techniques need to be researched so that organisms can be tracked on a range wide and seasonal basis.
- c. Presently there is no way to detect the three-dimensional nature of thermal plumes.
- d. Presently there is no way to detect the three-dimensional nature of circulation patterns in Mobile Bay.
- e. Costs to the users may be a problem, particularly where imagery is used over an extended time period.
- f. The composition of plant communities, particularly ecotones, cannot be determined within major biomes.
- g. The time interval between the day of ordering and the day of receiving data is too long for the information to be useful in certain cases.
- h. There is no centrally located source from which data could be retrieved with a minimum of time and red tape.

The following outline could possibly be used in structuring a research program at the Alabama Coastal Zone that could provide information needed to answer selected questions raised by users, or to facilitate users studies or decision-making processes. The research tasks are described and listed in order of priority or chronological sequence.

A. Research Task - Vegetative analysis of marshland

Priority - No. 1

Chronological Sequence - 2nd, 4th quarters

Description -

Objectives: To determine signatures of plant communities and to correlate these data with remotely-sensed data and imagery.

Materials and Methods: Radiospectrometric studies will be completed at the Point aux Pins marsh during the growing season and winter. Signatures will be obtained for Juncus roemarianus, Spartina alterniflora, Spartina patens, Distichlis spicata and Salicornia sp. These data will then be used to assay remotely-sensed data taken during the same quarters.

Value of research: This information would be highly useful in correlating ground truth data with NASA imagery and provide a prototype study for a complete vegetative analysis of the Gulf Coast.

B. Research task - Circulation patterns in Mobile Bay

Priority - No. 2

Chronological sequence - 1st, 2nd, 3rd, 4th quarters

Description -

Objectives: To determine circulation patterns in Mobile Bay throughout the year with remotely-sensed data and imagery.

Materials and Methods: Water soluble dyes will be used to determine circulation patterns.

Value of research: These data would enhance the on-going NASA-MESC contract relative to gathering parameter data.

C. Research task - Telemetry studies of colonial nesting birds by remotely-sensed data and imagery

Priority - No. 3

Chronological sequence - 2nd, 3rd quarters

Description -

Objectives: To refine and develop existing and new methods of tracking organisms on a range wide basis.

Materials and Methods: Cat Island, Portersville Bay, will be the study area where Cattle Egrets (Bubulcus ibis) will be "tagged" and tracked from their nesting to their feeding grounds. Other birds (i.e., Common Egrets, Snowy Egrets, Louisiana Herons, Little Blue Herons) nesting on this island are fish eaters and normally do not travel significant distances to feed. Cattle Egrets normally fly northward to the mainland where they feed on insects, thus making them ideal subjects for tracking in an area where topographical features will not prohibit the reception of radio signals.

Value of research: Information gained in this research will be of value in developing this "new tool" for wildlife management.

- D. Research task - Avian counts by utilization of heat sensory data

Priority - No. 4

Chronological sequence - 2nd, 3rd quarters

Description -

Objectives: To refine and develop techniques for aerial counts of birds.

Materials and Methods: Cat Island will be the study area for this project where heat sensory imagery could be collected and correlated with ground truth data and counts made from the deck of low flying aircraft. During the breeding season significant numbers of the fore-mentioned bird species congregate on this small (24 acres) island.

Value of research: This technique could enhance population studies of other endothermic organisms.

## ARCHAEOLOGY

Noel R. Stowe  
University of South Alabama

### INTRODUCTION

During recent years archaeologists have begun to realize the potential of remote imagery for archaeological research. While "old fashioned" black and white aerial photographs have long been used by archaeologists for constructing topographic maps, recent studies have made use of remote color photography, infrared photography, multi-spectral imagery, side-looking radar, and other remote sensing techniques for archaeological research. In archaeology remote imagery has for the most part been used for site surveys--the identification and location of archaeological sites. However, in recent years archaeologists have also used multi-spectral imagery for settlement pattern studies and related cultural-ecological research. While the preceding statements hold true for archaeology in general, little has been done with remote imagery in the Alabama coastal zone. For the most part, archaeologists in the southeastern United States regard remote imagery as a "toy" and are waiting to see Practical results before investing grant funds in this type of research. Three exceptions to this are: an attempt by archaeologists working for the Alabama Historical Commission at Fort Toulouse on the Alabama River to use infrared aerial photography to locate features associated with fort (Heldman 1973); a remote imagery site survey of the Tombigbee Valley (Walls 1974); and

feature location at Fort Mims with remote infrared color photography (Stowe and Hoyt, 1973).

At the present time a project is being developed by the Archaeological Research Laboratory at the University of South Alabama which would employ multi-spectral remote imagery on two different types of archaeological sites, a Rangia shell mound and a temple mound complex in the Mobile Delta. When this study is completed, the remote imagery coupled with ground truth, should demonstrate practical applications of remote imagery for archaeology in the Alabama Coastal Zone.

In addition to the utilization of various types of photographic remote-imagery side-looking radar should be especially valuable for locating and mapping archaeological sites in the Coastal Zone--an area where dense vegetation obscures most sites.

#### USER SUMMARY

Out of the eleven potential data users contacted during this study the majority, nine, indicated that their needs were geared to specific sites or geographical areas. Often the needs were for low altitude, less than 10,000 feet, high-resolution photographs that could be used for constructing topographic maps of specific sites or site identification and distribution studies. Most also felt that remote infrared photography could be used in searching for features associated with particular sites.

In interviewing potential users it was obvious that most had little knowledge of the types of imagery available for their specific needs. Many were unaware that the geographic areas where they were conducting archaeological research had been covered by the EROS and ERTS Programs. There was a tendency among the archaeologists interviewed to duplicate existing data rather than try to figure out what is available from NASA or the USGS and how to get it. Those archaeologists interviewed that had employed remote imagery in their research were using information provided by the U. S. Soil Conservation Service (Land Use Studies) or the Alabama National Guard. They were also unaware of the NASA Data User Laboratory at the Marshall Space Flight Center for ERTS data and the User Laboratories and "browse" files for EROS data at Bay St. Louis, Mississippi, and the U. S. Geological Survey "browse" files Tuscaloosa.

Most of the data needs of archaeologists covered in this survey are already available. The exception being low altitude imagery (less than 10,000 feet) for specific sites. There is also some interest in obtaining early aerial photographs to determine locations of destroyed sites. The major problem indicated by the archaeologists interviewed was a lack of knowledge of what was available, the cost, and where they could review and obtain the imagery needed.

The solution to this problem, of course, is providing the necessary information to area archaeologists. None of those interviewed knew of the local availability of remote imagery.

Those contacted requested more information on the periodic seminars in archaeology offered by the EROS Applications Assistance Facility in Bay St. Louis, Mississippi.

A possible answer to the problems encountered by the archaeologists interviewed would be a seminar(s) on Practical Applications of Remotely Sensed Data in Alabama. This meeting could be structured along the lines of the Symposia organized by the Geological Survey of Alabama and the U.S.G.S. should be on hand to provide additional information. May I suggest the Dauphin Island Sea Lab as a location for this meeting. Another obvious answer to this problem would be a kit specifically geared to archaeology containing examples of various types of imagery, altitudes, maps, showing areas covered, and prices.

I have attempted in a small way to dispel some of the mystique of remotely sensed data by having two short articles on the subject published in the "Newsletter of the Alabama Archaeological Society" during recent months. Also, I have been using high altitude transparencies provided by NASA to illustrate lectures. Also I have utilized remote imagery in current research. A reference list containing 40 titles on remote imagery and archaeology was mailed to all potential users during this survey.

User interviews are summarized in Appendix B-6.

#### RESEARCH PROGRAM

The Archaeological Research Laboratory at the University of South Alabama has begun research at two known archaeological



sites on the Alabama Coastal Plain. This research will integrate remote black and white photography, remote color photography, remote infrared photography, multi-spectral imagery, and side-looking radar with ground truth at the two sites. This program will be the first time this type of approach has been used in archaeological research on the Coastal Plain. The research should provide a basis for future research of this type in the Southeastern United States. The project will also provide information needed to answer questions raised by potential remote imagery users in archaeology.

The first site, the Bottle Creek Mound Complex (Ba2), is a large Mississippian temple mound and village site located in the Mobile River Delta. The exact location of 1Ba2 is: Longitude 87° 56' 20"; Latitude 31° 00' 37". The site is on the National Register of Historic Places which provides Federal protection and funding for the site.

1Ba2 was occupied for approximately 1,000 years. The first inhabitants were the Woodland People who used the site primarily for a gathering and hunting station. However, the heaviest occupancy of the site occurred during the Mississippian Period after 1500 A.D. It was during this period six sand-clay temple mounds were constructed at the site. The largest mound is 46 feet high. The Mississippian People had an agricultural subsistence base and must have farmed the area. However, the precise location of the agricultural plots are not known.

Remote imagery of the Bottle Creek site should provide basic data for mapping the site and analyzing the distribution of the mound groups. Also, remote imagery may show additional mounds in the area and shed light on settlement patterns. Of particular interest to the archaeologist will be the location of the agricultural plots which may show up in remote imagery.

The second site, 1Ba192, is a large Rangia shell mound located on Oak Leaf Bayou in the Mobile Delta. This site is approximately 14 miles south of 1Ba2. The exact location of 1Ba192 is: Longitude 87° 56' 31"; Latitude 30° 47' 33". A surface survey of the site indicated it covers approximately three acres. The maximum height of the shell mounds are 15 feet. To date no excavations have taken place at the site. However, surface collected artifacts indicate a Woodland and Mississippian occupation dating from 1500 B.C. to 1700 A.D. 1Ba192 was primarily shellfish gathering location and village area. Historic structures are also present on the site. This site is being nominated for the National Register of Historic Places.

Remote imagery at 1Ba192 should provide basic data for mapping the site and analyzing the distribution of the mound groups. Additional mound structures may show up in side-looking radar since the site is obscured with heavy vegetation.

The soils at these two sites and the surrounding terrain differ greatly. 1Ba2 rises some 55 feet above sea level while the surrounding swamp does not exceed the 10-foot contour. This

site is composed of sand and clay and is covered with oaks, maples, other hardwoods, and several pines. 1Ba192 is constructed of Rangia shells which attract cedars and other calcium-loving plants (calciphiles). The plant communities surrounding these two sites also differ from the plants on the sites. The Mobile Delta vegetation consists of cypress, gums and other swamp plants. Multi-spectral remote imagery should delineate the shifts in plant communities and it may be possible to formulate constants for locating these types of sites. Plant community shifts should be contrasted between the two sites and the surrounding swamp. Other phenomena should also be observed in the remote imagery of 1Ba2 and 1Ba192. Both low level and high altitude remote imagery should be made of both 1Ba2 and 1Ba192.

Mr. R. R. Morton, Chief of Operations, Earth Resources Office, and Mr. H. T. Svehlak, Remote Sensing Advisor to the EROS Applications Assistance Facility, have been contacted regarding this project. Some data has already been obtained and additional available imagery has been requested.

During recent months much attention has been shown concerning archaeological surveys in North America. Much of this activity has been brought about by recent legislation--The Moss Bennett Act--(Public Law 93-291), 88 Stat. 174. House Report No. 93-992 states that the amendment requires that Federal agencies to be cognizant of historic and archaeological sites and to take them into account in the early planning

processes and to provide adequate time and funds for archaeological site survey and salvage. Federal, Federally Assisted, and Federally Licensed undertakings which affect archaeological sites must be reviewed by an archaeologist before permits are made. This legislation has resulted in the few archaeologists practicing in the Southeast becoming "swamped" with Environmental Impact Statements. Remote imagery should, and will, play a major role in site location and distribution studies once the potential is demonstrated.

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## GEOGRAPHY

Neal G. Lineback  
University of Alabama

### USER SUMMARY

At present numerous local state and federal agencies are duplicating data collection, mapping and usage. As in the inventory of NASA Remote-Sensing Data Utilization, this researcher found several principal consistencies associated with data usage: 1) Most of the users were relying on ASCS (1:20,000) coverage on a continuous or sporadic basis; 2) few actually owned coverage of their areas of concern; 3) few were aware that there were additional coverages (NASA, State Forest Service and independent data); 4) none had considered any form of composite mapping, and 5) nearly all were interested in any mapping involving variables which directly or indirectly applied to their areas of concern.

The agencies which were interviewed were Farmers Home Administration, Soil Conservation Service, Alabama Forestry Commission, Department of Geology and Geography of the University of Alabama, Agricultural Stabilization and Conservation Service, Alabama Gas Corporation, and South Central Bell. Three agencies from which little or no information could be obtained were the Internal Revenue Service, Animal and Plant Health Inspection Service, and Southern Railroad. Summaries of user interviews are presented in Appendix B-7.



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Table 8 indicates those agencies that are apparently large users of remotely sensed data: Animal and Plant Health Inspection Service, Soil Conservation Service, Alabama Forestry Service, Department of Geology and Geography, and Agricultural Stabilization and Conservation Service. All of these agencies were in various stages of producing maps from remotely-sensed data and all but the first expressed interest in any geographic inventory which involved any of the variables with which they are concerned--even peripherally. Considerable expense and time are duplicated at the present because these agencies are compiling and analyzing many of the same data.

Remotely-sensed data are of indirect interest to the agencies previously mentioned; of far more interest are the single variable data that can be extracted, and the possibility of manipulating several variables into a meaningful complex relative to the planning charge of the agencies. The principal problem, then, is not so much the obtention of the remotely-sensed data as the discovery and use of a method of making something meaningful out of it.

Dynamic Variable Synthesis Mapping (DVSM) may well hold the key to solving the problem. Further experiments are needed in order to develop the methodology on a broad geographic scale and determine its limitations and utilizations.

#### RESEARCH PROGRAM

One of the principal needs prior to developing a plan for the development and/or conservation of any area is a geographic

Table 8. Summary of user practices and needs.

	<u>Amount of Remote Data Now Used</u>	<u>Resolution of Data Now Used</u>	<u>Add. Resolution Needs (More)</u>	<u>Frequency of Data Needs</u>	<u>Frequency of Data Use</u>
Animal and Plant Health Inspection Service	High	High	High	Annual	Summers
Farmers Home Administration	Mod- Low	High	OK	5-year	Occas.
Federal Crop Insurance Corp.	NA	---	---	---	---
Soil Conservation Service	High	High	High	Annual	Contin.
Internal Revenue Service	None	---	---	---	---
Alabama Forestry Commission	High	High/ Low	High	1	Freq.
Department of Geology and Geography	High	High/ Low	High	Annual	Contin.
Agricultural Stabilization and Conservation Service	High	High	High	Annual	Contin.
Alabama Gas Corp.	Low	High	OK	5-year	Occas.
South Central Bell	Low	High	OK	5-year	Occas.
Southern Railroad	Low	High	OK	5-year	Seldom

<sup>1</sup>Frequency of data depends upon infestations of diseases, storms, etc. Some areas require monthly monitoring when infestations are occurring.

inventory. Such an inventory optimally identifies the amounts, intensities and spatial relationships of as many static and/or mobile variables as will potentially be needed for an effective comprehensive plan. As a planning axiom, the statement, "One can't plan until one knows what there is to plan", is as true as ever.

An effective geographic inventory must certainly depend upon remotely-sensed data as the most valuable tool in the data-gathering process. These data, however, in their original forms (photos, prints, etc.) are not very useful as inventories themselves. Remotely-sensed data are non-discriminatory, and therefore the data must be synthesized, or broken into separate variables, in order to understand the varying amounts and intensities of the variables. Ideally, the variables should then be re-assembled, one at a time, and those which are not related to the problem for which plans are being made should be eliminated. The end result should be a mosaic of only those variables which need be considered.

#### TECHNIQUES

The above technique is basic to planning but until recently little had been done to design a method of accomplishing these ends. The small amount of work which has been done has been sketchy, seldom published and accomplished on isolated projects. One area in which slight more work has been done has been in the field of "composite or derivative mapping". The idea is an

old one with a few recent innovations, but it essentially involves using the data from two or more maps to produce a single composited map. The process can be valuable in planning; however, it is costly (high number of man-hours is producing extra maps) and, more importantly, slow. Furthermore, once the composited map is completed it cannot be changed, i.e. no variables may be added or subtracted.

A newer and more functional approach to the problem is being studied at the University of Alabama. Little has ever been done on the technique and much less published. The basic concept includes assembling a geographic inventory of physical, social and economic variables with each variable shown on a single map. The maps are produced on vellum utilizing classes of data that are compatible between maps, as well as symbology that is incompatible between maps (i.e. the symbols are designed so that they remain distinguishable. The technique is being tentatively called "Dynamic Variable Syntheses Mapping" [DVSM]).

The advantages of the technique are that: 1) any number of spatial variables up to four can be overlaid, 2) any order of the variables can be arranged, 3) variables can be added or subtracted at any time, 4) groupings of variables can be made in minutes, 5) composite maps can be obtained through standard ozlid copying techniques, 6) variables could include physical, social and economic data, 7) maps can be altered quickly and economically, and 8) the maps are highly durable. The only disadvantage of DVSM over standard composite mapping is higher

one-time printing costs. However, since the printing costs are a rather small component of the total costs of any geographic inventory, there should be no real concern about this. Furthermore, the high map durability and the absence of the need to composite by hand should more than offset the cost.

## ECONOMICS

Carl C. Moore  
University of South Alabama

### USER SUMMARY

The survey of economic users included university offices, government planning agencies and private firms. As shown in Table 9, all three categories of users indicated a demand for similar data for use in the following areas:

- 1) Population density survey
- 2) Housing survey
- 3) Industrial location analysis
- 4) Transportation network analysis
- 5) Survey of possible land-fill sites
- 6) Land use survey
- 7) Recreation planning
- 8) Highway planning
- 9) Erosion impact
- 10) Air and water pollution patterns

The survey of the business and economic users indicated a need for basically the same data, in terms of type of photograph and scale, and collected on an annual basis. From the survey it was also evident that a number of potential users in the business sector would contact one of the government agencies in seeking this type of information. For example, a business firm would probably contact the university, South Alabama Regional Planning Commission, Mobile Planning Commission, or the Mobile Area Chamber of Commerce rather than seek this information on their own.

Several of the agencies interviewed indicated that previous attempts had been made to obtain this information from the

Table 9. Remote sensing data utilization summary by business and economic users.

DATA APPLICATION	TYPE OF USER				
	Private Business	University	Private Research	Government Agencies	Chamber of Commerce
1. Population Density Survey		X	X	X	X
2. Housing Survey		X	X	X	X
3. Industrial Location Analysis	X	X	X	X	X
4. Transportation Network Analysis			X	X	X
5. Survey of possible land-fill sites				X	
6. Land use survey	X	X	X		
7. Recreation Plannint				X	
8. Highway Planning				X	
9. Erosion Impant				X	
10. Air and water pollution patterns due to economic development	X	X	X	X	X
Data Collection					
Annual	X	X	X		X
Semi-annual				X	
Monthly					

various government sources, but with little success. In most cases it was impossible to locate the required data through catalog listings, etc. The general consumers indicated a need for more detailed information or access to the data. If possible a local service to identify data sources and provide examples of available data.

All of the agencies were enthusiastic about the possibility of obtaining this type of data and indicated a long term demand for such data.

Summaries of the user interviews are presented in Appendix B-8.

#### RESEARCH PROGRAM

- A. Improve knowledge of potential business and economic Users
  - 1. Conduct a Users Conference in Mobile to accomplish the following:
    - a. Acquaint potential users with remote sensing applications.
    - b. Provide specific information and examples of data that is currently available and provide specific information concerning the procedure for obtaining this information.
    - c. Provide specific information with respect to cost of obtaining currently available data.
  - 2. Follow-up survey of potential users that attend the user conference.
    - a. On the basis of information received from the conference, attempt to identify additional data applications.



- b. Attempt to determine the demand for this data by estimating the planned expenditures for data by the potential users.

B. Determine the demand for local data service

1. Combine the information obtained in Part A with similar information for other sectors of potential users in order to estimate the demand for local data service.
2. Combine the data obtained from all sectors to determine the total demand for data (by types and possible dollar amounts).

From the information obtained at this point, it is clear that the utilization of remote sensing data is a function of three factors:

- a. knowledge of availability
- b. cost
- c. accessibility

A local data service would greatly increase use in the Mobile area through easy access and increased local knowledge of availability.

Appendix A

NASA REMOTELY-SENSED DATA USER LIST

FEDERAL:

U. S. Army Corps of Engineers:

Environmental Resources Division  
Harbor Development Section  
Operations  
Permit Section

U. S. Bureau of Mines

U. S. Department of Agriculture:

Farmers Home Administration  
Soil Conservation Service

U. S. Department of Commerce:

National Marine Fisheries Service  
National Oceanographic and  
Atmospheric Administration

U. S. Department of Interior:

Fish and Wildlife Service

U. S. Department of Transportation:

U. S. Coast Guard

U. S. Environmental Protection Agency

U.S.G.S., Metairie, Louisiana

U. S. Public Health Service

STATE:

Alabama Attorney General, Environmental  
Division

Alabama Clinical Laboratory Administration

Alabama Bureau of Inspection

Alabama Coastal Area Board

Alabama Department of Archives and  
History

Alabama Department of Conservation  
and Natural Resources:

Division of Fish and Game  
Marine Resources Division

Alabama Forestry Commission

Alabama Geological Survey

Alabama Highway Department

Alabama Historical Commission

Alabama Oil and Gas Board

Alabama State Docks

Alabama Water Improvement Commission

Auburn University:

USDA Agricultural Experiment  
Station  
Agronomy and Soils Department  
Anthropology and Archaeology Department  
Fisheries Department  
Water Resources Research Institute

University of Alabama:

Department of Anthropology  
Department of Geology and Geography  
Marine Science Programs  
Museum  
Office of Archaeological Research

University of Alabama, Birmingham:

Department of Anthropology  
Department of Microbiology

University of South Alabama:

Business Resource Center  
Department of Biology  
Department of Microbiology  
Department of Sociology and  
Anthropology

REGIONAL AND LOCAL:

Agricultural Stabilization and  
Conservation Service

Alabama Conservancy

Alabama Fisheries Association

Alabama Gas Corporation

Alabama Power Company

David Volkert & Associates, Inc.

Fort Toulouse Archaeological Project

Gulf States Paper Corporation

John H. Friend, Inc.

Mobil Oil Company

Mobile Chamber of Commerce

Mobile City Planning Commission

National Audubon Society

Orange Beach Fishermen's Association

Palmer & Baker Engineers, Inc.

South Alabama Regional Planning  
Commission

South Central Bell Telephone Company

Southern Natural Gas Company

Springhill College, Economics  
Department

University of Missouri, Archaeology  
Department

APPENDIX B  
USER INTERVIEW SUMMARIES

Appendix B-1  
GEOLOGY

User: Geological Survey of Alabama  
Contact: C. Daniel Sapp; Chief, Remote Sensing Section  
Date: September 3, 1974  
Interview: Personal

Summary:

Current data usage includes a variety of space, high-altitude and low-altitude imagery. Thermal infrared data is also used. These data are obtained from several sources, including NASA. A substantial budget is provided for purchase of remotely-sensed data. At the same time, there is extensive interchange with other agencies.

Data needs include further aerial and space photography, and magnetometer and gravimeter data. Although ERTS imagery can be used, resolution is insufficient for many tasks. Input frequency is variable, with an 18-day cycle being ideal for many geological purposes. These data will be used for environmental geologic studies, engineering geology, energy resources, ground-water resources, fault line studies, flood plain description, mapping, and coastal zone studies.



User: State of Alabama Oil and Gas Board  
Contact: Thomas J. Joiner, Assistant State Oil and  
Gas Supervisor  
Date: November 5, 1974  
Interview: Personal

Summary:

In general, low-altitude imagery is most useful; thermal imagery is used on occasion. Data are obtained in several formats, from several agencies. A substantial budget is provided for purchase of such information. This agency shares data with other State and Federal groups, especially the Geological Survey of Alabama's Remote Sensing Section.

Additional data needs include various types of photography, suitable for monitoring oil-related pollution problems and gross details of terrain related to oil production. Data formats and frequencies are variable. High resolution stereo imagery is required. Existing data storage and retrieval methods are adequate. Data are used for both development and regulation of petroleum resources.

User: U. S. Bureau of Mines  
Contact: James R. Boyle, Liaison Officer for State of Alabama  
Date: November 16, 1974  
Interview: Personal

Summary:

This agency does not now use remotely-sensed data in Alabama. There may be a need for large- and medium-scale aerial photography of mined areas. Thermal infra-red imagery may be used for research purposes. One-time coverage of all mined areas would be adequate for most purposes, while annual winter sensing would be useful for monitoring potential or existing mines. High-resolution data would be needed.

Although the Bureau does not have funds for these needs, agency enforcement programs would benefit from use of remote sensing data.

User: Auburn University, Water Resources Research Institute  
Contact: James C. Warman, Director  
Date: September 10, 1974  
Interview: Personal

Summary:

Regular, color and color infra-red photos are now used. Some bio-telemetry and radio transmission data have been used also. Data are obtained by various investigators funded by WRRI. There is considerable interchange with academic and governmental groups.

Additional data needs are diverse and difficult to define. Data formats, frequencies and resolutions vary with the particular research projects involved. Remotely-sensed data are used to characterize and manage water resources in Alabama.

User: Southern Natural Gas Company  
Contact: Frank MacArthur, Geologist  
Date: September 11, 1974  
Interview: Telephone

Summary:

In-house b/w aerial photos are now used in monitoring of company gas pipelines. Company funds are provided for this purpose, on a need basis. There is no significant interchange with other groups.

Data needs do not go beyond current practices. Input frequencies will be consistent to past practice, which requires complete coverage every five years, plus monitoring as needed.

User: Gulf States Paper Corporation  
Contact: Robert S. Inglis, Jr.  
Date: August 28, 1974  
Interview: Telephone

Summary:

A variety of aerial and space photography is used. Data are obtained from several agencies and from contract photography on occasion. There is no current or foreseen budgeting for purchase of remote sensing data. There is some interchange with State and Federal agencies.

Data needs will be served by conventional and infra-red imagery; ERTS data is inadequate. Formats and frequencies are variable, but regular repetitive coverage is not needed. Data are used to study pine beetle infestations inventory land, monitor growth of forests, compile maps, and conduct surveys of minerals, soils and water resources.

User: Alabama Highway Department  
Contact: Edward Eiland, Assistant Materials and Tests Engineer  
Date: August 22, 1974  
Interview: Telephone

Summary:

Aerial photos and thermal line-scan imagery are now used for many types of projects related to highway development. ASCS photos are relied upon heavily, and some contract aerial photography is purchased. The department uses in-house aircraft for some photography. Funds are provided for data acquisition.

Additional data needs in all types of space and aerial photography. Multispectral imagery is also needed. Annual data input is adequate provided a turn-around time of 30 days is possible. Storage of data should be in the form of plates rather than digital tape.

User: U. S. D. A., Agricultural Experiment Station  
Contact: Dr. Ben F. Hajek, Representative for Alabama Soils  
Survey  
Date: September 9, 1974  
Interview: Personal

Summary.

Regular and color photos are now obtained during the winter via the U. S. D. A. and Soil Conservation Service. Some funds are provided for purchase of data, and there is effective interchange with other agencies.

Future needs include additional conventional imagery, and special purpose multispectral photography. General soils mapping can be done from 9x9 photos obtained every winter season. Drought-period photos are also needed. High-resolution imagery is desired; ERTS data is inadequate. Data are used for soils mapping and drought stress crop studies.

User: Auburn University, Agronomy and Soils Department  
Contact: Dr. Ben F. Hajek, Associate Professor  
Date: September 9, 1974  
Interview: Personal

Summary:

Current data usage parallels that of the U. S. D. A. Agricultural Experiment Station. Data are obtained from the U. S. D. A. and SCS. No fixed budget for data acquisition is provided in the department budget. There is extensive interchange with other agencies and other departments within the university.

Other data needs include additional conventional aerial photography. Multi-band imagery is also desired. Seasonal coverage is required, with winter and drought periods of greatest concern. High-resolution imagery is needed; ERTS data is inadequate. Data are used in soils mapping, drought stress studies, clay mineralogy research, and soil desiccation.



Appendix B-2

HYDROGRAPHY

User: Mobil Oil Corporation (New Orleans) Exploration and  
Producing Office  
Contact: Mr. O. Alsop, Associate Civil Engineer  
Date: September 18, 1974  
Interview: Telephone

Summary: Potential User

Utilization will depend on the companies needs for surveying of new lease areas, compliance with Federal or State environment regulations, etc. No routine need was identified. Company funds would be available for purchasing imagery and photography, hiring of required personnel and outside consulting. This office was aware of imagery availability and had visited the EROS Office at Bay St. Louis. Present preference is high to medium resolution aircraft photography, single and multi-flight coverage and minimum turn around time for recieving products.

User: State of Alabama Bureau of Inspection  
Contact: Mr. Russell Wright, Director  
Date: November 11, 1974  
Interview: Telephone

Summary: Potential User

Mr. Wright was casually aware of NASA Remote Sensed Imagery and photography but totally unprepared to comment on specific aspects of its utilization by his office because of his lack of exposure to it. Generally, his feelings were that the Montgomery Main Office would certainly have an occasional need and that the district field offices could possibly identify frequent requirements. He strongly indorsed the concept of "Remote Sensed Data Workshops" to familiarize and train interested groups. Funds could be made available for purchasing imagery and photography and possible limited outside consulting but not for hiring additional personnel. Data preference: medium to high resolution, multi-flight aircraft coverage with rapid turn-around time on recieving products (nearly a real time requirement).

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User: State of Alabama Bureau of Laboratories  
Contact: Dr. T. S. Hosty, Director  
Date: October 23, 1974  
Interview: Telephone

Summary: Potential User

Dr. Hosty had in the past repeatedly tried to obtain standard and infrared imagery from various state agencies to utilize in conjunction with water pollution and red tide studies. He stated a variety of problems prevented him from succeeding. He expressed an active interest in organizing "workshops" for familiarization and training purposes. Funding for imagery and photography acquisition is possible. Data preference: medium to high resolution imagery, multi-flight coverage and rapid turn around time for receiving products.

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User: Alabama State Docks - Engineering Department  
Contact: Mr. William M. Black  
Date: September 23, 1974  
Interview: Telephone

Summary: No application

If the State Docks had a need for this type of data the Corps of Engineers would be responsible for handling it. Except for possibly planning considerations then needs are real time.

User: Marine Science Programs - University of Alabama  
Contact: Dr. George F. Crozier, Director  
Date: December 3, 1974 and February 18, 1975  
Interview: Personal

Summary: User

Present uses include ERTS-1 and NASA Aircraft products, utilization in specific Sea Grant, NASA and in-house MSP projects. These projects are primarily concerned with the Mobile Bay-Mississippi Sound complex and the immediate offshore waters. It is anticipated that the total need for all forms of imagery will increase over the next two years. Funding for imagery and photography costs, limited outside consulting and the hiring of new personnel (at the technician level) can be made available with both in-house sources and outside grants.

Future data needs include more frequent coverage (multi-flights of NASA aircraft - ideal coverage is four flights over a 24 hour period) and rapid turn around time for receiving furnished products. False infrared imagery, from Skylab, has proven to be useful and should be considered as one of the systems in future flights. The combination of ERTS-1 and 2 resulting in nine day coverage will greatly increase the use of ERTS imagery.

The main concern of the present and near future is the establishment of relationships between imagery features and environmental conditions. The acquisition of ground truth data and the processing, analysis and cataloging of these data in order to have a solid data base to work from is paramount.

User: National Marine Fisheries Service (Pascagoula)  
Contact: Secretaries only  
Date: December 2, 1974, December 9, 1974 and January 15, 1975  
Interview:

Summary:

Unable to interview appropriate individual.

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User: National Weather Service (Bates Field)  
Contact: Mr. Ray Burns, Chief Meteorologist  
Date: September 9, 1974  
Interview: Personal

Summary: No application

All data needs are real time.



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User: Food and Drug Administration  
Contact: Mr. James Sandelin, Consumer Safety Officer  
Date: December 2, 1974  
Interview: Telephone

Summary: No application

This office is strictly regulatory in Mobile.

User: Gulf Coast Technical Services Lab (FDA)  
Contact: Mr. R. M. McPhearson, Jr., Marine Biologist  
Date: December 3, 1974  
Interview: Personal

Summary: Potential User

A definite application for multi-flight aircraft coverage utilizing standard and infrared photography. Very little if any need for ERTS or Skylab. Rapid processing and shipping in order to have a minimum waiting period if paramount. Funds could be identified for purchase of imagery.

User: U. S. Coast Guard (Mobile)  
Contact: Lt. J. G. Palmer, Operations Officer  
Date: September 23, 1974  
Interview: Telephone

Summary: Potential User

Multi-flight aircraft coverage for environmental monitoring.  
Possible utilization of high resolution photography in aids to navigation positioning, relocation and hazards to navigation.  
Would need to evaluate the various products. Very interested in participating in workshops. Funds could be made available for aircraft missions to obtain photography and possibly some initial consulting.

Appendix B-3

ECOLOGY

User: Alabama Attorney General's Office  
Contact: Mr. James Cooper, Assistant Attorney  
Date: August 28, 1974  
Interview: Personal

Summary:

Major types of data used now include aerial photographs, water quality data, vegetation analysis, and any data pertinent to the status of coastal resources. This information is obtained from State and Federal agencies, as well as interested individuals and groups. There is little or no in-house data collection.

Projected needs related to remote sensing include environmental quality indicators, and ability to monitor them. Silt flow patterns in the Bay, changes in marsh vegetation, etc. are typical indicators. These patterns can be detected by both high and low altitude imagery, and possibly by telemetry. Frequency and resolution of data vary with the specific problem approached. These data would be used for legal proceedings.

User: Alabama Water Improvement Commission  
Contract: Mr. Richard Holston, Systems Analyst  
Date: August 28, 1974  
Interview: Personal

Summary:

Current data include field-collected and telemetric water quality/hydrology information. Of these, dissolved oxygen, pH, conductivity and temperature are considered critical. All water quality data obtained are stored in the National STORET data system. This system accomodates over a thousand parameters. Data is obtained from in-house operations, industries, the EPA, USGS, and Corps of Engineers.

Research related to ERTS applications in water quality monitoring by AWIC is being conducted by Auburn University and the University of Alabama.

Data needs focus on stream loads (consumption of dissolved oxygen), although many other parameters are desired. Daily monitoring would be ideal, but monthly measurements are satisfactory. Telemetry is the most promising form of remote sensing. Resolution of the data obtained varies with the parameter. Data are used to administer discharge permits, monitor stream flow, and allocate permissible loads.

User: Environmental Resources Branch, Corps of Engineers  
Contract: Mr. Jack C. Mallory, Ecologist in Environmental Studies  
and Evaluation Section  
Date: October 31, 1974  
Interview: Personal

Summary:

Data are now used to describe baseline environmental conditions, measure ecological damage, and predict environmental impacts of major activities in the coastal zone. Vegetation analysis, habitat quality, faunal patterns, water quality, hydrology, natural resources, erosion and other coastal characteristics are measured or assessed. Most data is obtained in-house or via contract. Other information comes from the EROS center near Bay St. Louis, and from other agencies. Bedgeting is not directed at remote sensing per se, but such data can be provided for on a project basis.

Data needs include subsurface bay contouring, and advanced techniques in remotely-sensed data analysis. Ground-truth data for marsh quality and type, and other parameters, are essential. Such data can take the form of telemetry or aerial photography (60,000 foot altitude or lower). Skylab imagery is also useful. Multispectral analysis of vegetation types is desired. Such data should be obtained seasonally at least.

User: Harbor Development Section, Corps of Engineers  
Contact: Mr. Jerry Lee, Chief, Harbor Development Section  
Date: October 31, 1974  
Interview: Personal

Summary:

Current data used by this office results from survey measurements of coastline changes with time. A small amount of funding is available to document complaints of excessive erosion in the Mobile Bay area. Aerial photography and ground-level surveys are used. Data are also obtained from the Coastal Engineering Research Center.

Additional data needs include low-altitude aerial photography taken often enough to document and quantify coastline changes. Some high altitude (eg. RB-57 or U-2) imagery may serve to indicate trends. The resolution of low-level photos would have to be less than 50 or 100 feet, since most erosion processes are rather slow. These data would be used to identify areas requiring erosion control practices.



User: Operations, Corps of Engineers  
Contact: Mr. A.F. Pruett, Assistant Chief of Project Operations  
Branch  
Date: October 31, 1974  
Interview: Personal

Summary:

This office receives data from other Corps offices (especially Environmental Resources), relating to submersed grass beds, oyster reefs, marshes, channel dredging, etc. Very little ecological data is actually gathered by Operations.

Data needs are those described by the Permit Section and the Environmental Resources Branch of the Corps.

Reports from these two offices are used to evaluate dredged material disposal site selection, shoaling patterns, maintenance dredging needs, and new channel or construction programs.

User: Permit Section, Corps of Engineers  
Contact: Mr. Don Conlon  
Date: November 8, 1974  
Interview: Personal

Summary:

Current data usage centers on low-altitude (2000 feet) aerial photography, plus ground-level verification of specific environmental features such as marshes, channel expansion, etc. Most of these photos are obtained from the Soil Conservation Service, or private contractors.

More frequent coverage of the coastal zone is desirable for this office's operation. High-altitude imagery will not provide the resolution required to monitor the small-scale permit actions handled by this office (less than 100 feet). Full photographic coverage is needed every one or two years. No special film requirements are anticipated.

Two comments made were that a browse file would be particularly useful, and perhaps could be partially supported by the Corps of Engineers. Also, long-term assurance of fly-overs would be helpful.

User: U.S. Geological Survey; Metairie, Louisiana  
Contact: Mr. William Martin, Staff Assistant for Environmental  
Analysis  
Date: August 28, 1974  
Interview: Personal

Summary:

The U.S.G.S. Metairie office monitors the operation of off-shore oil platforms, for discharged water oil content, solids, pH, conductivity, and temperature. These data must be collected in real time, to ensure that controls are activated if discharges exceed guidelines. Field surveys are conducted daily.

Additional needs involve safety shut-down controls on each platform or pipeline. In their opinion, remotely-sensed data technology is not suited to their requirements. If appropriate telemetry is developed, however, monthly measurement of water oil content may be useful (minimum resolution would have to be less than 50 ppm, which is the standard for oil content).

User: University of South Alabama, Department of Biology  
Contact: Dr. Robert Shipp, Assistant Professor  
Date: November 20, 1974  
Interview: Personal

Summary:

The Biology Department has active research interests in vegetation distribution, water quality, hydrology, natural resources, bacteriology, zoogeography, and other academic areas. The data now used is comprehensive and varied. Most data comes from in-house studies, the Corps of Engineers, contracts, grants, Alabama Water Improvement Commission, Conservation Department, and other agencies. Some funding has been obtained through MESC to support vegetation analysis using NASA imagery.

Data needs are poorly defined due to the wide variety of research interests. More exposure to remote sensing technology is necessary. Programs involving basic research, environmental assessments, and applied ecology are expected to utilize a wide range of remotely-sensed data.

Appendix B-4  
NATURAL RESOURCES

User: Orange Beach Fisherman's Association  
Contact: Mr. Carl McDuffie, President  
Date: January 30, 1975  
Interview: Telephone and Personal

Summary:

This group has participated in ground truth acquisition programs in the past and seem well informed as to the general techniques.

Currently there is little interest in using any remote data. There could be some interest in subsurface temperatures but the resolution would have to be quite fine since the concern is for bill fishing interests.

User: Dept. of Fisheries and Allied Aquaculture-Auburn University  
Contact: Dr. Wayne Shell, Chairman  
Date: January 30, 1975  
Interview: Telephone

Summary:

There is interest in sensing of nutrient levels in waters under consideration for culture. The technique involves analysis of aquatic vegetation via direct and chlorophyll-related imagery.

The acquisition of data is channeled through USDA sources at this time.

Additional interest is anticipated and they want to be kept informed of the availability of material. To be effective a relatively high frequency of data acquisition is likely to be necessary.

User: Dept. of Microbiology - University of Alabama in Birmingham  
Contact: Mr. Robert Christian, research technician  
Date: January 29, 1975  
Interview: Personal

Summary:

At the moment there is a strong interest in using imagery to define the current regime as it affects a series of established sampling points. They are concerned with water-borne pathogenic and indicator bacteria.

Data is needed on roughly a weekly or bi-weekly basis. There is also a strong requirement for experienced interpretation translation of the data to a form more directly applicable to their study.



User: Dept. of Microbiology and Immunology - University of  
South Alabama

Contact: Dr. Vernon Schoals, Chairman.

Date: January 29, 1975

Interview: Telephone

Summary:

No current need for this type of data exists, but the group does plan to enter the field of environmental microbiology as it relates to health problems. Consequently, a long range need is visualized which relates generally to water quality and distribution patterns in coastal streams and the Bay.

User: Alabama Fisheries Association  
Contact: Mr. Kent Seaman, President  
Date: January 30, 1975  
Interview: Telephone

Summary:

No use is seen unless sensing capabilities can be extended to fishery stock assessment, particularly shrimp. If this were possible, the data would have to be made available on an hourly-daily basis.

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Appendix B-5

CONSERVATION

User: Alabama Department of Conservation and Natural Resources  
Contact: Archie D. Hooper, Assistant Director  
Date: September 24, 1974  
Interview: Personal

Summary:

Enlarged contact prints have been used on a "need" basis to describe land and water use patterns. Low-level aerial photography has been obtained from various sources; jet aircraft imagery has been obtained through the HQ 187th TAC RECON GP, Dannelly ANG Base, Montgomery, Alabama. No budget is provided for such data. Data sharing is in-house at this time.

Data needs include remotely-sensed information on waterway utilization, thermal pollution, land use, and wildlife population dynamics. Data frequency varies, depending on the specific program need.

Cost is a major factor in remotely-sensed data utilization. Product information is needed.

User: Alabama Conservancy  
Contact: Mary Burks, Executive Director  
Date: October 2, 1974  
Interview: Personal

Summary:

No aerial imagery is being used by this group. Some funds might be available for securing information related to various pollution problems and land use impacts. Pollution studies may require daily data collection.

NASA exhibits would be helpful to describe products of remote sensing programs.

User: Alabama Department of Conservation and Natural Resources,  
Marine Resources Division

Contact: Wayne Swingle, Director

Date: November 13, 1974

Interview: Personal

Summary:

No remotely-sensed data is now in use, although funds are available. Two major areas of future data application include hydrography of Mobile Bay and associated river systems, and vegetation analysis of coastal marshlands. Photographic or other data should be acquired biweekly for hydrographic studies, and every 10 years for land use studies.

User: Alabama Power Company

Contact: John Grogan, Biologist

Date: November 4, 1974

Interview: Telephone

Summary:

Aerial photography has been used by this agency for cartography. These data are obtained via contract photography and from access to USGS imagery. Funds are available for data acquisition. There is no interchange with other groups.

Data needs include the following: cartography; resource management; and pollution studies (thermal and particulate). Daily data input is necessary for pollution monitoring.

Products and cost information is needed to assess applicability of remote sensing data.

User: National Audubon Society  
Contact: Dr. Alexander Sprunt III, Director of Research  
Date: October 24, 1974  
Interview: Personal

Summary:

EROS products have been used, in the form of enlarged contact prints. Some data has been obtained from the U. S. National Park Service. Funds are available for data acquisition; remotely-sensed data can be purchased when justified.

Data needs include hydrography of the Everglades National Park, land use (vegetation analysis), and population dynamics of breeding bird colonies, alligators and other wildlife. Behavior studies can be performed via telemetric tracking of tagged animals. Data input frequency varies with the program.

User: U. S. Department of the Interior, Fish and Wildlife Service  
Contact: Richard D. Curnow, Remote Sensing Coordinator  
Date: October 22, 1974  
Interview: Telephone

Summary:

Photographic data of various scales, and ERTS digital tapes are being used in research and operations of the Service. Most data are obtained from NASA operations, through EROS. Some contract aerial photography is used. Funds are available where needed. The Service cooperates with several other Federal and State agencies, including the USGS and EROS.

Data needs include information on distribution, size and number of specific habitat types or ecosystem components. Data frequency and scale is variable, and ERTS, NASA high-altitude, and low-level aerial photography are useful.

Appendix B-6

ARCHAEOLOGY

User: Alabama Historical Commission  
Contact: Mr. W. Warner Floyd, Executive Director  
Date: November 6, 1974, December 4, 1974 and December 7, 1974  
Interview: Letter, Phone, Personal

Summary:

The Alabama Historical Commission is federal liason for archaeological research in Alabama. The Commission nominates sites for the National Register of Historic Places, conducts site surveys, issues environmental impact statements, owns and administers archaeological-historical sites, and conducts excavations. The Commission is funded with state and federal funds amounting to several hundred thousand dollars yearly.

Remote Imagery was used on two Alabama Historical Commission excavations: Fort Toulouse and Fort Mims. Both of these sites are owned by the Commission.

In a letter dated December 4, 1974, Mr. Floyd stated "At this time the agency plans no research that could utilize remote-sensing techniques. Naturally we feel that there is a very real possibility that the Commission will in the future undertake research that will involve remote-sensing techniques. Therefore, I would greatly appreciate your sending along any information that could help us out in compiling research of this type". We are keeping Mr. Floyd informed and we plan to utilize remote-imagery techniques in future research conducted for the Alabama Historical Commission.



User: Auburn University at Montgomery  
Contact: Mr. David W. Chase, Instructor in Anthropology/  
Archaeologist  
Date: November 15, 1974, December 1, 1974, and December 8, 1974  
Interview: Letter, Phone, Personal

Summary:

Mr. Chase is conducting several site surveys and excavations on the Alabama River. Presently he is conducting a site survey for Hammermill Paper Company (Nanipacana Project) and is interested in locating 16th century Indian villages visited by DeSoto (Mauvila).

Mr. Chase has in the past utilized Alabama Air National Guard aerial photographs in his research. He is interested in obtaining infrared aerial photographs (altitude 5,000-10,000 ft.) for riverine areas in Dallas and Wilcox Counties. He needs relatively fine resolution permitting identification of specific sites. Chase also plans to use remote-imagery in future surveys.

User: University of Alabama, Tuscaloosa  
Contact: Professor David L. DeJarnette, Curator University of  
Alabama Museums/Archaeologist  
Date: September 15, 1974  
Interview: Letter

Summary:

Professor DeJarnette is Director of Archaeological Research for University of Alabama Museums. During the last 30 years the archaeological laboratory at Mound State Monument has conducted more archaeological research than any other institution in the state. For a number of years Mound State Monument was the only archaeological research laboratory in the state. Moundville's research interests are state-wide supported by federal, state, local and private funds. Monies for research at this institution amount to more than several hundred thousand dollars annually. Moundville is the repository for archaeological survey information in the state. Moundville in the past has used aerial photographs for site survey and mapping archaeological remains.

Professor DeJarnette referred me to Mr. Jerry Nielsen, Staff Archaeologist at the same institution, for information regarding the NASA Remote-Sensing Data User Need Profile.

User: University of Alabama, Tuscaloosa  
Contact: Mr. Jerry Nielsen, Staff Archaeologist  
Date: September 16, 1974, November 25, 1974 and December 7, 1974  
Interview: Letter, Phone, Personal

Summary:

Mr. Nielsen is Assistant Director and Field Supervisor for most archaeological projects at University of Alabama Museums. He stated that while they were presently utilizing aerial photographs for site surveys and mapping they had allocated no funds for this type of research. However, he is receptive to the possibility of utilizing remote-imagery on future projects. Mr. Nielsen is interested in seeing the results of the tests conducted at 1Ba2 and 1Ba192.

User: University of Alabama, Tuscaloosa  
Contact: Mr. Carey B. Oakley, Director, Office of Archaeological  
Research  
Date: November 16, 1974, December 2, 1974 and December 7, 1974  
Interview: Letter, Phone, Personal

Summary:

The Office of Archaeological Research at the University of Alabama, Tuscaloosa participates in archaeological site surveys and excavations throughout the state. They contract for federal, state, local and private funds. Funding for the Office exceeds two hundred thousand dollars yearly. Presently the majority of the research done by this agency are for the Tennessee Valley Authority.

Oakley stated that at this time no funding had been allocated for remote-sensing by that Office. However, Mr. Oakley has used aerial photographs for locating and mapping sites and he is cognizant of remote-sensing applications in archaeology for other areas. He is very interested in applying these techniques to his projects.

User: University of Alabama, Tuscaloosa  
Contact: Dr. Richard Kraus, Chairman Department of Anthropology  
Date: November 6, 1974, December 5, 1974 and December 7, 1974  
Interview: Letter, Phone, Personal

Summary:

Dr. Kraus has participated in archaeological research in the Plains Area, the Arctic, and Africa. However, administrative duties at the University preclude archaeological research at the present time. Dr. Kraus is knowledgeable of remote-sensing techniques in archaeology and is interested in its application on the Alabama Coastal Zone.

User: University of Alabama, Birmingham  
Contact: Dr. Roger Nance, Professor Anthropology/Archaeologist  
Date: November 6, 1974 and December 7, 1974  
Interview: Letter, Phone, Personal

Summary:

The Archaeological Research Laboratory at the University of Alabama, Birmingham conducts archaeological surveys and excavations with federal and state funds. Presently Dr. Nance is conducting a site survey aimed at studies in cultural ecology on the Alabama River.

At first Dr. Nance was skeptical of the role of remote-imagery in archaeology voicing the opinion that it was "little more than a toy with no practical application". When demonstrated that remote imagery was a valuable tool for delineating plant communities which have a bearing on cultural ecology, Dr. Nance modified his position. However, he stated that he would have to see the results of remote imagery applications on archaeological sites in Alabama before spending grant funds for this type of research.

User: University of Alabama, Birmingham/Alabama Historical  
Commission  
Contact: Dr. Donald Heldman, Archaeologist Fort Toulouse  
Project - now archaeologist in charge Fort  
Michilimacknine (Michigan)  
Date: December 6, 1974  
Interview: Personal

Summary:

During the initial stages of this project Dr. Heldman was archaeologist at Fort Toulouse on the Alabama River. Subsequently he has changed jobs and is now in Michigan. Dr. Heldman utilized infrared aerial photographs attempting to locate archaeological features at the Fort. While he does not plan to conduct archaeological research on the Alabama Coastal Plain in the near future he is interested in the proposed test demonstrations at 1Ba2 and 1Ba192.

User: University of Missouri  
Contact: Dr. John Cottier, Research Archaeologist  
Date: October 5, 1974 and December 15, 1974  
Interview: Letter, Phone

Summary:

Dr. Cottier is a proponent of remote-imagery and its application in archaeology. He has used various types of remote-sensing in archaeological research conducted in Yucatan and Southern Missouri. He was very helpful in providing basic data for this study.

In the Fall of 1974, Dr. Cottier was planning to return to Auburn University and continue previous research on the lower Alabama River. However, he will continue his research in Missouri for at least one more year. Cottier expressed a great interest in the utilization of remote-imagery on the Alabama Coastal Plain and requests information on our research at 1Ba2 and 1Ba198.



Appendix B-7

GEOGRAPHY

User: Alabama Gas Corporation  
Contact: Don Wiseman, Assistant Supervisor of Engineering  
Date: December 20, 1974  
Interview: Telephone

Summary:

Some ASCS photography is now used on a sporadic basis. Funds are available to purchase such data. There is no interchange with other agencies. All future remote sensing needs will be filled by new aerial photos being developed by the City of Birmingham. These data are used to inventory lands for new pipelines.

User: South Central Bell  
Contact: W. R. Booth, District Engineer  
Date: November 18, 1974  
Interview: Telephone

Summary:

A small amount of low-altitude coverage is obtained from the Corps of Engineers or ASCS once a year, to locate and inventory transmission lines. No budget is provided for purchase of remotely-sensed data, however. A scale of 1:20,000 is adequate. Input frequency is unimportant, but need not exceed once per year. No greater needs are foreseen.

User: Alabama Forestry Commission  
Contact: Walter Young, Aerial photographer  
Date: December 2, 1974  
Interview: Telephone

Summary:

Various sources (ASCS, in-house) and scales of remotely-sensed data are used. Contract aerial photography (in-house) is used extensively. Both regular and color infra-red imagery is obtained for inventories of forests, beetle damage, storm damage, etc. Interchange with lumber companies is extensive.

Data needs include better low-level false color infra-red, but only in spots. These should be in 9x9 stereo pairs. Annual coverage will be suitable, but a rapid (2-3 weeks) product return is necessary.

User: Soil Conservation Service  
Contact: James M. McCullough  
Date: October 11, 1974  
Interview: Personal

Summary:

Current data include various scale photos, which are obtained via contract aerial photography, and from the ASCS. Some budget is provided for such data acquisition. There is considerable interchange with other Federal and State agencies, including the ASCS, and FHA.

Data needs include full coverage at least every two years. Color infra-red imagery will be useful in environmental monitoring. Positive prints, with stereo coverage, are needed, at a scale of approximately 1:4000. Data will be used for soil mapping, conservation planning, watershed planning, and land use planning.

User: Farmers' Home Administration  
Contact: Mixson C. Byrd  
Date: October 11, 1974  
Interview: Personal

Summary:

Minor use is made of existing ASCS remote imagery, at varied scales. No funds are provided for data acquisition, and photos are only used in the ASCS office. Data are used to plot isolated farm acreage or size of farms on which loans are to be made.

More frequent coverage (every three years) is needed. Photo resolution should be adequate to allow identification of automobiles (ie. 1:4000).

A central browse file office is recommended.

User: Agricultural Stabilization and Conservation Service  
Contact: Warrence Foster, County Lead Clerk  
Date: October 11, 1974  
Interview: Personal

Summary:

The agency makes extensive use of remotely-sensed data. Full coverage is obtained via contract aerial photography, every seven years. Local ASCS offices have budgets to cover the expense of these data. ASCS offices make these data available to many other users, including the Soil Conservation Service, FHA, Forestry Commission, etc.

Shorter intervals between data collections are necessary (ie., from seven to three years). Stereo coverage is needed, at a scale of 1:4000.

User: University of Alabama, Department of Geology and  
Geography

Contacts: Dr. Neal Lineback, Dr. Stephen Stow

Date: October 11, 1974

Interview: Personal

Summary:

These departments make extensive use of several types of remote sensing data, including ERTS, ASCS, and NASA high-altitude photography. These data are obtained from EROS and the ASCS. Some departmental monies are available to purchase aerial imagery; other funds are obtained from specific contracts and grants. The department shares information and imagery with other university departments, as well as with State and Federal agencies.

Projected data needs include more thermal mapping, and more frequent (annual) ASCS-type of coverage. Local data storage (eg. browse file or other) is needed. Data would be used for land use analysis and interpretation.

Appendix B-8  
ECONOMICS

User: David Volkert and Associates, Inc.  
Contact: Dick Sute, Project Engineer  
Date: October 31, 1974  
Interview: Telephone

Summary:

This company is involved in industrial, transportation and other development which may benefit from remotely-sensed data. A need for both regular and color infrared photography is anticipated. Topographical maps would be used to verify photo information. Annual data collection would be suitable. Contract aerial photography is now being used for site planning and environmental impact assessments.

Examples of products and costs are considered necessary to effective evaluation of potential use of available information.

User: Palmer and Baker Engineers, Inc.  
Contact: Mason Tuttle, Project Engineer  
Date: November 6, 1974  
Interview: Personal

Summary:

Aerial imagery could be used successfully in transportation and land use planning operations. Water flow patterns would be needed to assess erosion problems related to road construction. Either annual or semi-annual coverage would suffice for general purposes, but more frequent data collection would be necessary for certain projects. Aerial photography is already being used. No interface with other users was reported.

User: Mobile Area Chamber of Commerce  
Contact: Craig Mason, Director of Research  
Date: September 18, 1974  
Interview: Personal

Summary:

The Chamber of Commerce may use remotely-sensed data to monitor population patterns and impacts, air quality problems, and hydrologic problems related to salt water intrusion. Annual and seasonal imagery (aerial photographs) are needed, although real-time monitoring of highly polluted areas may require more frequent observation. Ground truth data are now obtained from other agencies, including the County Board of Health and the U. S. Public Health Lab on Dauphin Island.

User: Mobile City Planning Commission  
Contact: John Stuardi, Assistant Director  
Date: September 20, 1974  
Interview: Personal

Summary:

This agency requires data suitable for characterization of local land use, traffic and erosion patterns. Regular and color infra-red photographs would be needed, at a scale compatible with USGS maps. Annual data collection is adequate. Some photography is now obtained from the U. S. Agriculture Land Survey and the Alabama Highway Department. This and future material is needed for planning purposes. The Commission interacts with the Mobile District Corps of Engineers.

Examples of available data should be seen in order to determine applicability for a particular use.



User: South Alabama Regional Planning Commission  
Contact: Don Pruitt, Executive Director  
Date: August 30, 1974  
Interview: Personal

Summary:

Current data usage includes land use, population density and transportation planning. Data is now obtained from State and Federal agencies, as well as from studies funded by this agency. Nearly all other groups in this area interface with SARPC. Data needs include photography related to transportation, development, housing, demography, etc. Generally, annual or semi-annual data will suffice, but quarterly or monthly input is needed in some cases.

High altitude (U-2, RB-57) photography provides good data, but low-level photos are needed for verification.

Local viewing equipment is needed.

User: University of South Alabama, Business Resources Center  
Contact: Dr. Carl C. Moore, Director  
Date: August 26, 1974  
Interview: Personal

Summary:

Applications of remotely-sensed data include housing, regional land use and industrial development patterns. Low-altitude aerial photography is best suited for these users, but some high-altitude photography is useful also. Annual data is needed. Limited data is now obtained from U. S. Census material and Chamber of Commerce data, for planning of industrial development and impact studies.

Data cost-sharing is desirable, because of limited financial resources.

User: Spring Hill College, Economics Department  
Contact: Dr. Cort Schlichting, Chairman  
Date: September 26, 1974  
Interview: Personal

Summary:

Annual aerial photography could be used to describe land use and development patterns in the Mobile area. Photos which allow identification of numbers of housing starts, dwellings and commercial sites would be needed. No prior use of aerial imagery was reported.

User: John H. Friend, Inc.  
Contact: John H. Friend, President  
Date: September 4, 1974  
Interview: Personal

Summary:

Market research applications may include determinations of population density, socio-economic characteristics of the population, land use, traffic patterns, parking, retail store patronage, recreation and development patterns. Aerial photos are needed which allow identification of vehicles, persons, etc. Semi-annual data is desirable. Such information is now obtained from various sources. Most studies are performed for private clients and cannot be shared.